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SCIENCE AND THE WAR

ST. ANDREW'S DAY, November 30, saw the customary anniversary meeting of the Royal Society, held this year, not at the Society's rooms in Burlington House, London, but at Trinity College, Cambridge, where the offices of the Society were removed on the outbreak of war.

In the general part of his anniversary address, Sir William Bragg spoke on the position of the Royal Society, and, by implication, of men of science generally, in relation to the war. He pointed out that a very large number of fellows of the Society are serving the nation in different capacities, but he is clearly not satisfied that full use is being made of the scientific resources of Great Britain. Sir William thinks—and his views will meet with general agreement—that in spite of the widespread acknowledgment of the effectiveness of science, the ways of using science and scientific men are being discovered too slowly. There can be little doubt that our administrators, as a body, lack that knowledge of the fundamentals of science which would enable them to make better and speedier use of its fruits. Sir William put this basic knowledge in the form of four "propositions":

"1. Science, that is to say, the knowledge of Nature, is of fundamental importance to the successful prosecution of any enterprise."

"2. Science is of general application. There is not one science of chemistry, another of electricity, another of medicine and so on: there are not even distinct sciences of peace and war. There is only one natural world, and there is only one knowledge of it."

"3. Fruitful inventions are always due to a combination of knowledge and of experience on the spot."

"4. There are difficulties peculiar to the application of science to war purposes", in that it is not easy to maintain during times of peace the necessary connexion between this special application and the general body of science.

These generalizations are well worth putting on record, for their significance extends far beyond the present times of stress which have provoked them.

Sir William then turned to consideration of the way in which more use might be made of science. He believes that, for the present, "the most successful ways of using knowledge are personal and elastic", rather than through a formal Ministry of Science, and he threw out the suggestion that the Royal Society, possibly through a selected small group of fellows, might be used as a regular consulting body, giving advice as required and also being kept so informed of the progress of events that "it might foresee occasions and needs".

The suggestion should be given very earnest consideration. The task of selecting a suitable group of fellows of the Royal Society for this purpose would not be easy, but there is no gainsaying that the Society has a unique range of consultant experience on which it can call. In addition to the direct use of such a body, it may be suggested that close collaboration with the Central Register of specialists maintained by the Ministry of Labour in association with the Royal Society and professional institutions would have valuable consequences. In this way the Register might serve, not only as a source of scientific and other trained personnel, but also, as an index to the state of research in Great Britain, to suggest lines of investigation which may enable us, in Sir William's words, to "foresee occasions and needs".

DISCOVERY AND INVENTION IN WAR-TIME

APART altogether from limitations of resources and materials imposed by national needs and the diversion of scientific workers from creative or fundamental work to emergency problems of defence and the like, the impact of war is rarely favourable to scientific advance. War necessities may, and often do, stimulate invention, but they rarely favour, and indeed commonly retard, scientific discovery and the advance of knowledge. Even in such special branches as aviation, the War of 1914–18 actually retarded technical progress, and as has been pointed out in these columns from time to time, warped the development of civil aviation.

Under conditions of war, the conservation of resources, and above all of creative and fundamental thought and work, becomes a matter of prime importance, and we may well return with increased interest to the symposium on invention presented some years ago before the Institution of Mechanical Engineers, as well as to the highly suggestive study of C. Nicolle, "Biologie de l'Invention" (Paris: Librairie Felix Alcan), published in 1932. Although the symposium on invention was concerned primarily with the evolution of invention and the development and exploitation of invention relative to patent law and economic recovery, the broader questions of the place of invention in industry and its relation to scientific discovery received passing notice.

Even in regard to invention, we may not assume too readily that all is, and will be, well under war-time conditions. The needs of a time of emergency are apt to stimulate invention to solve day-to-day or urgent problems rather than the long-range problems, and particularly those involved in the reconstruction and re-integration of social and economic life after the war. If the latter needs and problems are entirely neglected, there are likely to be many gaps in our knowledge and many unsolved problems which will hinder us reaping the full benefit of our war-time effort. Nor should it be forgotten that it is not only from *ad hoc* research or investigation that the solution or clues to the solution of even the most urgent problems have always come. Fundamental research has a stimulating and fertilizing value which should make us chary of starving it even in the direst necessity.

M. Nicolle's little book, however, made a more serious attempt to probe the theory or mechanism of scientific discovery, to which some attention was given in the symposium. In spite of frequent discussions, we are little nearer to the understanding of this question than in the time of Bacon. Fundamental creative ability may indeed defy analysis, but a knowledge of the conditions which encourage or stimulate it is worth while, all the more when the need to conserve resources is most imperative.

It is recognized that discovery precedes invention possibly by long spans of time, and invention itself presupposes knowledge based on experiment and observation. Broadly speaking, as Mr. H. W. Dickenson pointed out in the symposium in question, a discovery is the apprehension of the order of Nature, while invention is the guidance of the known forces of Nature into new channels for the benefit of man. What we are primarily concerned with here, however, is the ability to evolve new schemes or contrivances, commonly called inventiveness, and the factors which are favourable or unfavourable to the exercise or development of this faculty.

Many factors have similar influences on both invention and the more creative act known as discovery. The initial effort required either in creative thought or inventiveness can be repressed or prolonged by excessive knowledge. The deadening effect of the abundance of technical and scientific literature to-day has frequently been the subject of comment, whether from the point of view of encouraging excessive specialization and pre-occupation with the details of a narrow field or from the mental indigestion it may cause.

This position, however, arises in part from the chaotic condition of scientific and technical literature, and the failure of scientific workers to organize a really adequate and effective abstracting service, with the advantages which the expert handling of such literature and the elimination of duplicated effort would afford. The stringency of war-time conditions in regard to paper and printing may yet supply an added stimulus where the rational motive has been insufficient to overcome inertia or prejudice.

Even when allowance is made for such retarding influences, it has to be admitted that fundamental

creative ability defies analysis. Although, at the present time, a wide experience is more necessary than ever, conscious thinking out in science is a process rarely if ever leading to novel results. As Sir J. J. Thomson observes in "Recollections and Reflections": "New ideas come more freely if the mind does not dwell too long on one subject without interruption. It is, I think, a general experience that new ideas about a subject come when one is not thinking about it at the time though one must have thought about it a good deal before. It is remarkable that when ideas come in this way they carry conviction with them and depose without a struggle ideas which previously had seemed not unsatisfactory".

The creative mind concentrates more or less intensely for a less or greater space of time upon a problem for which no solution is known. A new and correct solution comes to it in exactly the same way as a forgotten name or fact often comes to us after we have cudgelled our brains in vain for it. Just how or what determines the incidence of the new idea remains an unexplained mystery. We can only note the predisposing factors which stimulate it or appear to accompany it.

One of these has already been noted—the break in conscious thinking about the subject. Dr. H. S. Hatfield pointed out in the same symposium that in early youth the power of assimilation may afford a criterion. The creative mind frequently has much less power of assimilation, but along some particular line it actually runs ahead of the matter presented to it, re-inventing what is known. Initiative is another characteristic, even if we dissent from the proposition that genius is merely a capacity for taking infinite pains. It is rare, however, to find genius without that capacity, at any rate in directions which serve its ends.

Again, creative work is rarely accomplished by the steady round of daily hours most favourable to routine work. It has mostly been accomplished in violent bursts of overwork at high pressure, alternating with periods of comparative idleness in which the unconscious mind is able to order its content. Problems are not solved more slowly by easier going: rather they are not solved at all unless the attack reaches a certain intensity. The creative act, as M. Nicolle points out, is essentially irrational. We cannot impart merely by training the sense of values and the capacity to discriminate instantaneously between essential and non-essential. We can only hope to supply the conditions or opportunities in which they flourish and develop and in which they can be most readily stimulated.

Creative genius, again, is something more than intelligence. It is not simply the acquisition of new facts and their systematization. Such powers may be possessed to a high degree by minds incapable of creative originality. It is indeed true that if genius is to accomplish anything effective, it must be accompanied by good sense, and that, even so, collaborators may play an indispensable part by keeping the creative spirit in touch with realities and supplying just that capacity to work out the consequences or practical applications of the discovery with which genius is apt to be too impatient to trouble. Anything that endangers its spontaneity or limits its freedom, however, threatens the creative spirit. True though it may be that genius may triumph over any misfortune or obstacle, it is only those who succeed of whom we hear.

In science, no less than in art, creative work flourishes in an atmosphere of sympathy and enthusiasm, where the mind is quickened and encouraged to expand. We lay constraint or even discipline on the truly original at our peril. Such minds are rare, but it is difficult to distinguish between latent genius and the normal intelligence. It is one of the dilemmas of wartime that we must seek to preserve for the creative few the full freedom of thought and work essential, while the many accept the discipline and constraints demanded in the national interests. More, rather than less, in war than in peace, the price of liberty is eternal vigilance, and no severer task lies upon the shoulders of scientific workers than that of seeing that all the vigour which they bring to national service in its myriad needs, and the readiness with which they accept sacrifice and discipline with their fellow citizens, shall not be allowed to impair for one moment the disinterested search for truth. They who claim to be defending the cause of freedom and truth must see to it that, within their ranks at least, the quest for truth is unimpeded, and that no political considerations are allowed to fetter discovery or exposition of its results when these are prompted by the disinterested desire to enlarge the bounds of knowledge. Ultimately it is in the truths won in many fields of knowledge—physical, economic, social—by creative minds that alone we can build the new social order which will make the present sacrifices worth while.

THE COMPLETE CORRESPONDENCE OF LEEUWENHOEK

Alle de brieven van Antoni van Leeuwenhoek (The Collected Letters of Antoni van Leeuwenhoek). Uitgegeven, geïllustreerd en van aanteekeningen voorzien door een Commissie van Nederlandsche geleerden (edited, illustrated and annotated by a Committee of Dutch scientists). Deel (part) 1. Pp. 454 + 40 plates. (Amsterdam: N. V. Swets and Zeitlinger, 1939.)

IN 1931 when the Royal Dutch Academy of Science and the leading medical authorities in Holland were considering how best to celebrate the tercentenary of the birth of Leeuwenhoek in 1632, it was resolved to prepare and publish a complete annotated edition of his scientific writings, accompanied by English translations. English-speaking people will be grateful for the translations, and will appreciate cordially the compliment implied in this decision. The Royal Society of London from the very outset gave valuable encouragement to its humble Dutch correspondent, and in doing so displayed the soundest judgment, since Leeuwenhoek's earliest letters by no means foreshadowed the important results he was later to achieve; and this is all the more surprising when it is remembered that his first letter was written at the age of forty.

The present instalment of this difficult and important enterprise, the first of twenty, is an imposing quarto volume which includes a general introduction and preface by Prof. G. van Rijnberk, the president of the committee, the first twenty-one letters written between April 1673 and February 1676, in Dutch and English versions, a discussion by Dr. A. Schierbeek of Leeuwenhoek's micrometric methods as related to modern standards, brief notes on the persons mentioned by Leeuwenhoek and the annotators, bibliography, indexes in Dutch and English, and thirty-nine plates based on photographs of the original drawings which have survived, and also some modern figures which the committee considered essential to elucidate the text. The work is well printed, but the paper used in the plates is so friable that in the reviewer's copy one sheet had broken at the hinge and worked loose before the book was used. Also we suggest that it is a mistake to reproduce line engravings as half-tone blocks—the line block gives a better result, is less costly, and can be printed on durable paper. It must be allowed that the illustrations of the work generally admit of some improvement. In particular the figures of Leeuwenhoek's microscopes are unworthy of an edition which aspires to present to us the *complete* Leeuwenhoek. In 1921, Roemer published photographic reproductions of the Utrecht microscope which were admirable.

Of the twenty-one letters now listed one has never been available and its contents are therefore unknown, and two others are merely covering letters of only a few lines each. Hence this volume deals with but eighteen of the relevant letters. It has, nevertheless, taken several years to prepare, so that unless the rate of publication can be materially accelerated the entire correspondence of some two hundred and eighty letters can scarcely appear in the lifetime of the present generation. A similar Dutch undertaking—the works of Chr. Huygens—was commenced in 1888 and is still proceeding. All the eighteen letters above mentioned were published in Holland *in extenso* in 1931 with English translations, except those which had been more or less completely translated in the *Philosophical Transactions*. The present volume, therefore, contains nothing new apart from those passages which were rejected by the *Philosophical Transactions* translator. These omissions prove to be of little importance, except perhaps the section on digestion which forms the conclusion of letter 18 (12).

The first concern of the English reader will be with the accuracy of the translation. Most Dutch biologists speak and write English so well that it would seem unnecessary, and even ungracious, to offer them any assistance. Nevertheless, there are criticisms to be met, and we would strongly urge the Dutch committee to anticipate them by submitting the English version of all future volumes to the censorship of one of their English friends. The translation, or rather the interpretation, of Leeuwenhoek, due largely to his chatty and inexact manner of expressing himself, can be quite speculative and laborious. We had hoped that these difficulties, magnified in Great Britain by lack of familiarity with the language and customs of seventeenth century Holland, could and would be resolved by a Dutch-speaking committee. When the *Philosophical Transactions* translator found himself in deep waters, as he frequently did, he took refuge in a literal translation of Leeuwenhoek's words. *That*, however, is the way of ease and perplexity. In Dobell's book the problems were faced with uncompromising determination and precise knowledge, and most of them yielded to this treatment. Our Dutch friends, on the other hand, have made the mistake, as we think, of

adopting the orthography and faulty text of the *Philosophical Transactions exactly as printed*, not even excluding typographical errors. Obvious downright mistakes are of course corrected, and those parts which were omitted in the *Philosophical Transactions* are translated into *modern* English. The result, leaving us as it does practically where we were, is somewhat disappointing.

We admit that to edit the whole of the Leeuwenhoek correspondence with the meticulous scholarship of a Dobell would be a stupendous task, and could not be entrusted to one man, but this is a case where the counsel of perfection is not an alternative but the only course to follow. In consequence of the method adopted by the Dutch Committee, the *Philosophical Transactions* letters are presented to us in a hybrid dialect which even an Englishman cannot fully comprehend without recourse at times to the Oxford Dictionary, nor is any attempt made to parallel the distinctive style of the original. Moreover the same word may have a different connotation in seventeenth and twentieth century English. We cannot but feel that, if only for the sake of uniformity, the *Philosophical Transactions* versions should have been corrected *and* modernized, so as to reduce the whole text to the same idiom.

A few examples as reprinted by the Dutch Committee from the *Philosophical Transactions* will illustrate the point: p. 33, "Whence I am prone to collect" [inclined to the opinion]; p. 107, "in some few places [in the liver] the blood lay vein-wise . . . dispersed through the Liver out of the veins" [? veined like marble]; p. 109, "These Globuls I judged to be blood, and that, pricking our body with a pin without hitting a Vein, the bloody Globuls did issue from between these [muscle] filaments"; p. 123, "the red Globuls agitated pesle-mesle, and as if each Globul had yet a second motion, and that about its axe" [pell-mell and axis]; p. 197, "the holes in the Nerve were not round nor so regularly posited by one another" [punched]; p. 303, "appeared to me in *my* Microscope, of the thickness of a great Bread-knives back"; p. 305, "it oused but very slowly through blew Paper"; p. 317, "then will each degree of hardness . . . cause more or less sharpness of taste upon our Tongue, and consequently produce a su[i]table operation" [specific reaction]. In this passage the editors have modernized the spelling of "sutable", and in another place they have substituted "I prepared" for "I did myself prepare", but why they should have done so in these and a few other cases whilst ignoring all other archaisms is not explained.

Here are some examples of their modern English to which objection could be taken: p. 173, "the yolk-cells give these eggs a troubled [turbid] appearance"; p. 209, "examination of the optic nerve by picking [teasing] it"; p. 217, "post-mortal changes in the optic nerve"; p. 221, "inhomogenous nature of tobacco-smoke"; p. 223, "containing in its inner hollow a grain of gun-powder"; p. 227, "the sting of a scorpion is not letal" [use of German instead of English equivalent]; p. 349, "egg-pod" [shell membrane]; p. 355, "That is why it may make [give] the impression of a cavity"; p. 357, "the medulla often contains air, and then appears to be black, owing to a total reflexion [!] of the light". To translate "Heer liefhebber" as "gentleman amateur" is to carry literality too far. "Philosopher" or even "virtuoso" (as on p. 303) would be more suitable.

Apart from a number of minor misprints the following points should be included in the list of errata and addenda: pp. 41 and 73, Letter 5 (3) as published in the *Philosophical Transactions* includes a part (par. 6) of Letter 2; p. 45, the plate of the bee in the Lancisian library in Rome is dated 1625 and bears the name of Stelluti; p. 75, "And exhibiting my Blood to myself in very small parcels, the globuls yielded very colour"—the *Philosophical Transactions* version which is followed has it correctly "very little colour"; p. 151, the belief that nerve fibres were tubes which transmitted fluid contents survived until the middle of last century; p. 155, the whole paragraph refers to the vagus and none of it to the optic nerve—in the latter part of the paragraph Leeuwenhoek was perhaps describing the pulmonary plexus of the vagus; p. 175, the suggestion that Leeuwenhoek discovered the eggs of the liver-fluke in the gall bladder *of the rabbit*, but not the oocysts of Eimeria as suggested by Dobell, is so highly improbable as to be unacceptable without further evidence; p. 213, dark ground illumination was undoubtedly described by Hooke in 1678, which lends colour to the conjecture that Leeuwenhoek may have hit upon it in 1675; p. 219, sections as aids to anatomical study were used before Leeuwenhoek by Boyle (1663), Hooke (1665), and Grew and Malpighi (1672); p. 331, the attribution of the discovery of Daphnia to Goedart by Swammerdam is difficult to explain but nevertheless an error, and the reference to the "Historia Generalis" 1665, Tab. VI, should be 1669, Tab. I; p. 383, in discussing Leeuwenhoek's estimate of a hairsbreadth the annotator has misunderstood a statement by Dobell, who did *not* assume that Leeuwenhoek's wig was made of human hair—in fact the contrary is expressly implied.

If some of the shortcomings of this work have been dwelt upon, it must not be concluded that its merits are not considerable and impressive. The

defects we have mentioned are remediable for the past and preventable in the future. The discoveries of Leeuwenhoek are of such importance as to exact the highest standard of performance on the part of those who seek to do him honour. In the efflorescence of the arts and sciences which occurred in Holland in the seventeenth century, Leeuwenhoek occupies a commanding place, and therefore any commemorative edition of his writings should reflect the universal reverence in which the genius of this remarkable man is held.

F. J. COLE.

MINERAL NAMES

Descriptive List of the New Minerals, 1892–1938

Containing all New Mineral Names not mentioned in Dana's "System of Mineralogy", sixth edition, 1892. Compiled by George Letchworth English. Pp. vii + 258. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 18s.

MR. GEORGE L. ENGLISH, well known to mineralogists all over the world from his long connexion with the firm of Ward's Natural Science Establishment at Rochester in New York State, has compiled from various sources an alphabetical list, with definitions, of all new mineral names not included in the sixth edition of Dana's "System of Mineralogy" published in 1892.

Beginning in 1897, the Mineralogical Society of Great Britain has published fourteen lists of new mineral names, compiled by Dr. L. J. Spencer and printed at the end of each volume of the *Mineralogical Magazine*. In each list the names were arranged alphabetically, but as the fourteen lists contain more than 2,100 names, it will be a great convenience now to have all the names available in one volume.

For several years the Mineralogical Society of America has had a Committee on Nomenclature at work. The final report of this Committee has recently been adopted by the Society, and Mr. English has been able to incorporate in his list the changes in names proposed. These changes fall under two headings: (1) those merely involving a different spelling from that adopted by E. S. Dana in the sixth edition of the "System of Mineralogy"; and (2) those calling for a definite choice between two alternatives both in common use among American and British mineralogists. It is satisfactory to note that a certain measure of agreement was reached between the American Committee and a committee appointed by the Mineralogical Society of Great Britain at a joint discussion which took place in Washington in 1933, and the only names of common minerals for which the spellings preferred by the United States mineralogists are not likely to be taken into general use here are: 'sulfur' for 'sulphur', 'hematite' for 'hæmatite', and perhaps 'feldspar' for 'felspar'.

The spellings 'feldspar' and 'felspar' have both been in general use in American and British mineralogical and geological books for nearly a century and a half. The spelling 'felspar' was introduced in 1794 by R. Kirwan in the second edition of his "Elements of Mineralogy". In his first edition he had spelt it "feltspar" and "felt spar", and he explained his change of spelling in a footnote: "This name seems to me derived from *fels* a rock; it being commonly found in granites, and not from *feld*, a field; and hence I write it thus, felspar." In this assumption Kirwan was wrong. The name was not German, but Swedish. It was first introduced by D. Tilas in 1740 in the first volume of the *Transactions of the Swedish Academy of Sciences*. It seems that Tilas wrote "feldtspat" in his manuscript, but in the printed paper the name appears with no fewer than four different spellings on a single page: "feldt spat", "feltspat", "fältspat" and "feldtspat". Linnæus used "fältspat" in 1748 and so did Cronstedt in 1758. Contemporary German works gave both "Feldspat" and "Feldspath", and in English we find "field-spar" (1772), "feltspar" (Kirwan 1784), "feldspar" (Hutton 1785), "fieldspath" (Beddoes 1791) and "feldspat" (Wedgwood 1792).

Tilas had published no explanation of the derivation of his name, but it is believed to refer to the abundance of the mineral in the tilled fields in the rapakivi granite district of south-western Finland, and its derivation from the Swedish "feldt" or "fält" (= field) is undoubted. J. D. Dana in his famous "System of Mineralogy" adopted the spelling "feldspar" from the start (1837) and this spelling has remained in general use in the United States, while Kirwan's spelling "felspar" was adhered to in Great Britain. In the last few years, since the discussions with the American Nomenclature Committee, many mineralogists in Great Britain have adopted the spelling "feldspar", but this has not been accepted by the leading mineralogical and geological periodicals. Fortunately, whichever spelling is used, no confusion in meaning will arise.

THE RARE EARTHS

Gmelins Handbuch der anorganischen Chemie Achte völlig neu bearbeitete Auflage. Herausgegeben von der deutschen chemischen Gesellschaft. System-Nummer 39: Seltene Erden. Lief. 1: Einleitender Überblick, Geschichtliches, Vorkommen. Pp. 122+iv. (Berlin: Verlag Chemie, G.m.b.H., 1938.) 14.25 gold marks.

THIS part of Gmelin's "Handbuch" contains a historical account of the discovery and occurrence of the so-called 'rare earths', a description of their minerals and an account of their geographical distribution. The discovery of large deposits of monazite sand in Brazil, in North and South Carolina and in India has perhaps rendered the designation rare earths misleading, but it is in common use, although in this work the term includes the elements scandium and yttrium as well as the fascinating cluster of elements which bridges the gap between barium and hafnium.

In spite of much previous work dating back to the year 1794, the mystery of this cluster remained unsolved until the work of Moseley on atomic numbers and of Bohr on atomic structure provided the solution. The number of elements was fixed at fifteen, of which all but one are definitely known. The existing data about No. 61, which is called illinium or florentium, are derived from X-ray spectral lines in the *L*- and *K*-series. The unusual similarity of chemical properties of the others is associated with peculiarities of atomic structure, the outer shells of electrons being alike in all cases.

The most characteristic property of the group is their paramagnetism, which begins at cerium and increases progressively to lutecium. This property is associated with the occurrence of valency electrons in the fourth quantum group. Moreover, whereas the basicity of the tervalent elements increases from aluminium to lanthanum, it decreases very slightly but steadily from lanthanum to lutecium. A similar increase and decrease is noticed in the dimensions of their ionic radii (the lanthanide contraction). No mention is made of the recent work of Klemm and Bommer, which reveals a periodicity of atomic volume with high peaks at europium and ytterbium.

Modern views on crystal structure have had an important bearing on the development of geochemistry. The rare earth minerals occur chiefly in granites and pegmatites, and their occurrence is determined more by lattice dimensions than by valency; the small ionic radius of aluminium seems to render it incapable of replacing rare-earth metals to form isomorphs.

A comprehensive table gives the proportions of the various elements in many minerals as deduced from spectral intensities.

MECHANICS OF SPORE DISCHARGE IN TERRESTRIAL PLANTS

Spore Discharge in Land Plants By Dr. C. T. Ingold. Pp. vii+178. (Oxford: Clarendon Press; London: Oxford University Press, 1939.) 7*s*. 6*d*. net.

DR. INGOLD has for some time paid special attention to the discharge of spores, particularly in the group of fungi, stimulated as he gratefully acknowledges by the important contributions Prof. A. H. R. Buller has made to this subject in his six volumes of "Researches on Fungi". Dr. Ingold's own publications have so far dealt only with fungi, but following up this interesting subject he has examined critically the spore discharge of cryptogamic land plants as a whole, and the present volume deals with the Bryophyta and Pteridophyta as well as the Fungi. It is perhaps natural considering the inception of his investigations that his latter group of plants receives preferential treatment, but we must remember also that the methods of spore liberation among fungi are more varied.

Reviewing these seriatim, the author deals with the water-squirting mechanism of the Ascomycetes and other fungi, with the discharge due to rounding-off of turgid cells, with the catapult mechanism of Sphærobolus and with the drop-excretion process of basidiospore discharge. The mechanism of this latter process is not as yet fully explained. Prof. Buller has stated that "it may be that the force of surface tension is used in some way to effect discharge". Dr. Ingold gives a very careful consideration to this suggestion and from his calculations concludes that there appears to be sufficient surface energy to discharge the spore: but that it is not easy to see how this energy could be mobilized to bring about the discharge. A final solution of the problem, he thinks, must be sought

in a more intensive study of some cases of abnormal discharge which have been reported by Buller.

In connexion with the basidiospore discharge Dr. Ingold describes his observations, accompanied by excellent drawings, on the liberation of the basidiospores of Puccinia and also of the so-called "shadow yeast" *Bullera alba*, which from the nature of its spore formation must be included among the Basidiomycetes. In the Bryophyta he describes in detail the scattering of the spores from the open capsule of *Cephalozia bicuspidata* by the spring mechanism of the elaters released by water-rupture. This latter process is also dealt with in considering the spore discharge of the ferns and of Selaginella.

In concluding a final chapter given up to a general consideration of spore discharge in Cryptogams, the author makes a plea for the experimental study of this process in the ordinary botany courses at the universities. The realization of this very reasonable hope will be greatly facilitated by the publication of the book under review, which not only describes clearly the many fascinating methods of spore discharge and dispersal found in cryptogamic land plants, but also contains a large number of excellent illustrations, most of which have been specially drawn to explain the various mechanisms of dispersal. The historical introduction and the bibliography will be of great value to students of this very interesting subject.

DETERMINANTAL LOCI

The Geometry of Determinantal Loci

By Prof. T. G. Room. Pp. xxviii + 483. (Cambridge: At the University Press, 1938.) 42*s*. net.

PROF. T. G. ROOM uses the symbol $(|p, q|_r, [n])$ to denote the locus, in projection space $[n]$ of n dimensions, whose equations are given by the vanishing of the determinants of order $r + 1$ of a matrix (x_{ij}), of p rows and q columns, whose elements are linear functions of the (general homogeneous) co-ordinates in $[n]$. This he calls a determinantal locus; particular determinantal loci are the conic in [2] and the quadric surface, cubic curve and cubic surface in [3], with respective symbols $(|2,2|_1, [2])$, $(|2,2|_1, [3])$, $(|2,3|_1, [3])$ and $(|3,3|_2, [3])$. $(|p,q|_r, [n])$ may be *projectively generated* as the locus of the meets of the $\infty^{r(p-r)}$ sets of corresponding $[n-p+r]$'s of q projectively related $[n-p]$-stars, and, since $(|p,q|_r, [n])$ is the same as $(|q,p|_r, [n])$, there is a conjugate projective generation obtained by interchanging p and q. Thus the cubic curve in [3] may be regarded either as the locus of the meets of corresponding planes of three related pencils or as the locus of the meets of corresponding lines of two related point-stars. If p and q are equal, the two conjugate generations are of the same kind.

Prof. Room's book, in which he uses both synthetic and algebraic methods, is divided into three main sections. Part 1 deals with the general $(|p,q|_r, [n])$ and Part 2 with the loci obtained by specializing the matrix (x_{ij}), with particular consideration of the cases in which this matrix is symmetric or skew-symmetric. Part 3 is an exhaustive and fascinating account of the different types of determinantal quartic primal and associated loci in [4].

The general theorems proved in the first two parts are of a formidable nature, but they are freely illustrated by examples in which the algebraic quantities are given particular numerical values. The author recognizes that it is generally the special cases which are of the greatest interest, and, while sympathizing with his evident desire to keep the book to reasonable proportions, we should have liked to see him develop some of them further.

In the generation of the cubic surface in [3] by three related point-stars, there are six sets of three corresponding planes which meet in a line instead of a point. These six lines and six others, which arise from the conjugate generation and are paired with these, form a *double-six* of lines, with the property that no two lines of the same set of six intersect and each line of one set meets all but one of the lines of the other. The remaining fifteen lines of the cubic surface arise naturally, though not so simply as this, from the projective generation. In chapters iv and xiii, Prof. Room describes many new such configurations of linear spaces with remarkable intersection properties.

The class of determinantal loci is very extensive. It includes, for example, all plane algebraic curves, and, in fact, as the author claims, almost all loci of whose projective properties anything is known are either determinantal loci or closely connected with them. The great diversity of the problems solved and the naturalness with which they fall into the author's scheme fully justify that claim. The book consists very largely of original researches, and among these the chapters on the representation of spaces by points and the chapter and appendix on the freedom of loci are particularly interesting.

The index and table of contents are admirably complete and the author suggests a useful course of selective reading. D. W. B.

X-RAY ANALYSIS AND THE STRUCTURE OF MATTER*

BY SIR WILLIAM BRAGG, O.M., K.B.E., PRES.R.S.

WHEN the new methods of X-ray analysis were first introduced a quarter of a century ago, there was naturally no clear realization of the extent and character of the fields of research in which they would eventually be employed. Certain applications were found for them at once, but the years have brought wide and unexpected developments. Some of these are gathering themselves together, and, in conjunction with other methods of physics and chemistry, begin to form what might well be called a new branch of science.

In the early phase of the X-ray crystal studies, the object of interest was the perfect crystal; in the later phase, attention is directed towards the departures from perfection, which turn out to be of the greatest interest and importance.

EARLY WORK ON CRYSTAL STRUCTURE

It will be remembered that the method of analysis of the structure of matter by means of X-rays was based upon a suggestion made by Dr. M. von Laue. If the atoms in a crystal were in regular array, the passage of ether waves through the crystal should be accompanied by diffraction effects, provided that the lengths of the waves were of the same order of magnitude as the spacings of the atoms. In the case of the ether waves emitted by an X-ray bulb—if indeed the X-rays were ether waves, of which there was some doubt at the time—there were reasons to suppose that the wave-lengths were of the magnitude required. The experiment was made, and was successful.

The diffraction effects provided means whereby the crystalline arrangements could be calculated. The researches of the first few years of X-ray analysis were therefore concerned with the character of the crystalline arrangement in a number of the simpler cases. As confidence grew and skill increased, more difficult structures were attacked, and indeed it has been very surprising to find what complicated structures can be unravelled. One helpful circumstance has been the existence of families of substances, since the progressive differences in the members of a family give rise to corresponding changes in the diffraction patterns. Thus, for example, the large family of silicates was examined and the connexions between composition and diffraction effects, and again between the latter and structure, were observed and compared. Certain simplicities and uniformities then appeared, and it became possible to put in order a mass of details which had not previously appeared to have any relation with each other.

It was not long before the results in this field of research became so numerous that books of no small size were required to contain them. In thousands of cases, the dimensions of the unit cell of the crystal were determined, and at least the space group or character of the arrangement of the atoms within the cell. In a number of these cases the exact relative positions of the atoms could be found, though this additional task has often been formidable. Work of this kind continues, and rightly so, to be the occupation of many investigators. All such work belongs to the first phase to which I have referred.

IMPERFECTIONS OF CRYSTALS

The application of the X-ray methods has for some time been entering on a second phase. It now deals with a natural phenomenon differing entirely from that which was the first to be examined. The earlier work was concerned with the arrangement of the atoms in a perfect crystal, that is to say, a body in which the mutual forces are balanced, and the arrangement is complete. Thermal movements may still be there, but the average dispositions of the atoms are settled, and are uniform throughout the body of the crystal.

It is doubtful whether there is such a thing as a perfect crystal large enough to be handled; perhaps the crystals of diamond and graphite are nearest to perfection. In almost all cases there are deviations from complete uniformity. A crystal that has every appearance of being perfect may consist of an assemblage of minute crystallites, more nearly perfect individually but lacking uniformity of orientation to a greater or less degree. Other bodies that do not appear to be crystalline at all may consist of crystallites oriented so irregularly that the bodies seem to be isotropic. The crystallites may vary in size as well as in relative orientation. Two or more crystal forms may be present in the same body, so mixed together that only the X-ray methods can make any attempt to disentangle them. Sometimes one

* From the presidential address to the Royal Society, delivered on November 30.

greater lattice overrides in a more or less regular fashion a smaller lattice, as a pattern of ploughed fields may override a pattern of furrows. Also a lattice may be distorted by strain. In a substance in the liquid state there may be associations and partial arrangements sufficient to show X-ray diffraction.

Moreover, arrangements and dimensions may vary with time, both in solids and liquids; some forms or extents of arrangement may even disappear, new forms may appear at the expense of the old. Perfection of crystalline arrangement is a goal which is never achieved. In fact the processes of the world are based upon such deviations from perfection, and their continuous modification. If all arrangements of atoms were complete, there would be nothing left but stagnation and the peace of death.

It will be seen, therefore, that a new field of research of extraordinary interest is being opened up. It is in this field that the physicist and chemist, and indeed scientists of every persuasion, must look for explanation of many of the properties of their materials, such as their relations to magnetism and electricity, thermal conductivity, tensile strength, various surface effects and so on; and also the time changes in these properties, such as the creep to which the engineer has to give so much attention. Properties such as these have been called by Orowan and others the 'sensitive' properties, since they depend on the particular state of a body, which state in turn depends largely on the conditions of the new field of which I am speaking. The biologist finds interest in it, because the life processes seem to involve the relations between large aggregates, molecules or assemblages of molecules, with one another or with media in which they are imbedded. Somewhere in this field life and matter are first found in association.

It may seem unreasonable to expect help in the resolution of such complications from the X-ray diffraction effects. It is to be remembered, however, that the X-ray photographs are very rich in information. The gratings are three-dimensional and may be examined from a variety of aspects; each photograph or spectrometer record is a two-dimensional diagram of positions and intensities of diffracted spots. A light spectrum of the ordinary kind is uni-dimensional only. The photographs vary in definition, being less easy to read as they deal with more complicated cases; but the technique is rapidly improving.

MOSAIC EFFECT

The earliest of these phenomena of the larger field was the so-called mosaic effect. A crystal of rocksalt, for example, is a mass of small crystals, each of which approaches to regularity far more completely than the whole. The separate crystallites are not in perfect alignment with each other. Hence arose one of the perplexities of the early days. It was extraordinary to find that the less perfect crystal reflected the X-rays in greater intensity than the more perfect, and that the reflections from the face of a crystal—quartz, for example—might be increased if the surface was roughened. The puzzle is solved if we remember that, as Darwin and others pointed out, one crystallite may screen another. If the orientations of the two are exactly the same, and they are set at the proper angle for reflecting the incident X-rays, the first crystallite will partly absorb the rays in producing its own reflection and the lower will not have its full opportunity. But if, as is usual, the crystal is moved through small angles about the above setting so as to give every crystallite its chance—provided that the X-rays can penetrate the crystal so far as to reach it—and if the second is in the right orientation for reflection when the first is not, then the incident rays get through the first and are reflected by the second; the integration of all effects therefore gives a larger total when the crystallites are not parallel.

This mosaic character is very common, even in crystals of the purest material. There are indications, as remarked by Goetz and others, that in some cases at least it is the state of greater equilibrium. Thus W. A. Wood shows that crystals of copper and other metals of extreme purity are reduced by cold working to crystallites in more or less complete disarray. The substances do not then return to their former state, though they can be taken some way towards it by moderate heating. To restore them to their original state it would be necessary to begin over again from the melt. A similar effect was shown by Ewald to occur in the case of rocksalt. It may also be significant that of the two forms of diamond examined by Robertson and Fox, that which is the more transparent to infra-red and ultra-violet, and may therefore be taken to be in greater internal equilibrium, is also the one in which there is some mosaic character.

If this form of disintegration of a larger crystal into crystallites is really due to the release of energy, it might be expected to proceed until the process was complete and the substance became amorphous. Wood shows that it does not proceed indefinitely and that the copper crystallites have an average linear dimension of about 700 A.; for silver the figure is 800, for nickel 1200, and so on. The disintegration ceases at a certain point. The metals were of extreme purity. Unless it appears

that the mere trace of impurity governs the effect, it must be supposed that the disposition to form aggregates of definite magnitude is present in the copper atoms themselves.

The presence of crystallites of a definite pattern, their dimensions, their preference for any particular orientation in relation to the body which contains them and their proportional amounts are all determined by the X-ray photographs. It is to be remembered that the diffraction spectra of a compound of different crystallites do not modify or disturb each other's evidence. The data on which calculations are based are the forms and intensities of the spots and lines in the X-ray photographs. The calculations are often difficult and lengthy because so many factors have to be taken into consideration; in fact there is plenty of evidence, and the most troublesome part of the business is its interpretation.

Applications to Metals and to Large Molecules

It will be readily understood that such measurements as these can be of great assistance in the study of metals. It is possible to examine in a new and most effective way the phase diagrams of the metallurgist, and the various effects of composition, temperature and time, and this not only for binary alloys but also for ternary and still more complicated mixtures. With these powers in hand, and with the remarkable accuracy of the modern X-ray spectrometer, which can show minute changes of form due to temperature or an admixture of foreign atoms, and can show also any variations in the extent of order and disorder in the atomic arrangements, it is not surprising that theoretical metallurgy has acquired a new life and that practical metallurgy begins to gain thereby.

Since the X-ray methods can do so much to discover the composition of molecules, even very large molecules such as the phthalocyanines (Robertson) or the sterols (Bernal, Crowfoot and others), and also to determine the arrangement of the molecules in crystalline aggregates, and yet further to find any preferred orientations that there may be, the methods can be fitly used for the examination of fibrous materials. In cotton, silk, rubber and many other substances there are long-chain molecules which are linked together into crystallites having preferred orientations along the length of the fibre. So also nerve, muscle, horn and such-like contain proteins and keratins in fibrous forms. It is even possible, as Bernal has shown, to find some details of the composition, structure and arrangement of immense molecules such as those of a virus. Very interesting papers on these subjects have been communicated to the Royal Society, some of them during the present year.

It is to be observed that the extension of the X-ray methods to these larger scale problems is greatly facilitated by extrapolation from simpler observations. In the case of organic substances, the modes of assemblage into characteristic combinations of atoms, such as the association of carbon atoms in the benzene ring, are governed by rules which are so closely followed in the simpler cases that they can be assumed to hold in the more complicated. These rules relate to the distance from atom to atom in various cases, and the mutual orientations of atoms. In this way very important suggestions have been made in respect to the construction of the more difficult assemblages.

It is to be remembered, of course, that there are other physical methods of observation which contribute to the understanding of the complex substances of Nature, which are all the more efficient now that the X-ray methods are able to make their characteristic contribution. First of all comes chemical science, the power of which is so obvious and well known that I need not do more than refer to it. Optical properties have been found to be extremely useful. So also the magnetic properties are found to be closely related to structure. Thus, for example, the disposition of a molecule containing benzene rings can often be predicted from diamagnetic measurements.

The sum total of these powers, some new, some old, all reinforcing each other in a common advance, is so great that, as I have already said, a new field of inquiry of first-rate importance has been well entered. That which the eye can see is one thing: that which the microscope reveals is another. Far beyond any vision is the individual atom and the atomic nucleus, of which so much has been discovered in recent years. But a vast range of magnitudes lying approximately between 10 and 10,000 A. has never been accessible to the direct attack which the ranges on either side of it have experienced. Within this range lie all the processes which are concerned in the building of living substances, animal and plant, and in the changes of growth and decay. In this range lie also elements that are the origin of the properties of our materials, alloys, glasses, fibrous substances of all kinds, and here take place transformations which change these properties, some of them especially rapidly when urged by heat, some so slowly that centuries must pass before they become visible or effective. The recent advance into this new field is only the preliminary to what is sure to follow. We have before us an inquiry of supreme interest.

CAMBRIDGE UNIVERSITY EXPEDITION TO JAMAICA

BY DR. V. J. CHAPMAN,
UNIVERSITY OF CAMBRIDGE

THE Expedition left England in two parts, on June 15 and 22, and was scheduled to return on September 19. Owing to the outbreak of war, the main party left Kingston a few days earlier than was anticipated, but in spite of this change of plan the principal items in the programme were carried to a successful conclusion. The personnel consisted of Dr. V. J. Chapman, the leader, Dr. H. Hamshaw Thomas, who took charge of the forest party, Mr. J. A. Steers, who took charge of the schooner party on her voyage around the island, Mr. J. S. Colman in charge of the zoology, Mr. W. R. Philipson, Mr. J. Lofthouse the surveyor, Mr. K. R. Sporne, and Mr. D. J. Crisp. We were fortunate in being able to co-opt three persons in Jamaica, and it is a pleasure to record how much their inclusion helped the expedition. The local members were Mr. C. E. Hamshere who assisted the geographers, and Miss O. Baxter and Miss L. Scudamore who aided the forest party. The Expedition was largely financed by the Royal Society, and our thanks are due to that body and other institutions which provided money, and also to the Government departments of Jamaica and private residents in the island whose ready co-operation greatly facilitated our work.

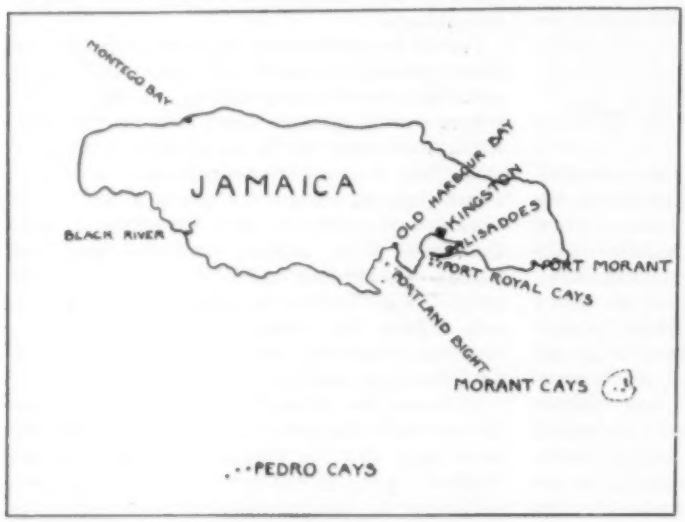

Fig. 1.

The primary object of the expedition was to study the development of the cays and of the shore line, especially in the neighbourhood of Kingston, and also the role of the plants and animals concerned in the process. A visit was first paid to the Morant cays which lie on a shoal about 60 miles south-east of Kingston (see accompanying map, Fig. 1). When, later on, the cays near Kingston were examined, it became apparent that the Morant cays form an independent group the structure of which is quite unlike that of the Kingston cays. The Morant cays, four in number, are simple sand cays composed of *Halimeda* and shell sand together with coral fragments (Fig. 2). These cays were unique among those investigated in that the beach rock forms promenades comparable to those of the low wooded islands of the Great Barrier Reef. These structures always occur on the windward sides of the cays and are heavily eroded. In some of the depressions crystalline salt and algæ appeared to be combining to produce a hard crust similar to that formed on the surface of the promenade, and it is hoped that an analysis of the crust and the algal-salt mixture may throw some light on its formation. Whilst the height of the promenades on the Queensland islands suggested that a slight fall in sea-level had occurred, we came to the conclusion that this was not the solution on the Morant cays, but that storm waves and spray would probably account for their height.

Of the cays in Portland Bight, all but two are built up largely of *Halimeda* sand, whilst those off Port Royal (outside Kingston Harbour) form a graded series extending from the outer cays, with coarse coral on the exposed south-east and south sides, to the inner sandy cays, with only a few boulders on their weather sides. The similarity of the environment of these two groups of cays makes it very difficult to explain why one set is so different from the other. Many of the cays

Fig. 2.
IPOMŒA AND LOW SAND-DUNES, SOUTH EAST CAY, MORANT CAYS.

possess one or more lines of beach rock lying at varying distances off-shore, and it would seem that these represent former outlines of the cays and they might therefore be used to indicate changes of shape. A study of the physiography of the Palisadoes, together with what is known of its past history, suggests very strongly that this sand and shingle spit rests on a rocky ledge, and that it has united several former shoals or cays which are now represented by the stable salients Plumb Point, Little Plumb Point, and Rocky Point. There are three factors which have controlled the development of this spit in the past and which will determine any future change.

(1) Hurricanes. These are capable of opening up breaches in the spit and re-isolating the individual cays.

(2) Earthquakes. These may have the same effect.

(3) Sand and shingle movement from east to west due mainly to wave action. Normally the evolutionary work of this last factor predominates, but it has been upset time and again in the past by the single or combined effect of the first two.

In other parts of the world where coral reefs are to be found, the calcareous red algæ play no inconsiderable part in their formation, and hence it was surprising to note how insignificant this group of algæ are in Jamaican waters. It may be said that the cays and reefs of Jamaica are conspicuous by the comparative paucity of living coral and calcareous red algæ, although conditions would appear to be favourable for both. *Halimeda*, in giving rise to a sand, is the only alga which plays any real part in shore-line development, but even this genus is not as abundant as might be expected and it seems that its maximum abundance must have been reached in the past. The observation that many of the cays do not appear to occupy greater areas than they have in the past, as revealed by lines of former beach rock, strongly supports the thesis that fresh supplies of *Halimeda* sand are not being produced at a great rate.

The mangroves, of which there are three principal species, *Rhizophora mangle*, *Avicennia nitida* and *Laguncularia racemosa*, form the principal vegetation which is concerned with shore line development in this part of the world. They are completely absent from the Morant cays, and this can probably be explained by the fact that the dominant winds blow from the south-east and so any seeds would have to travel over a considerable distance in order to reach the cays. With a persistent wind in this quarter, colonization from Jamaica is out of the question even though it is so near. By way of contrast, the cays in Portland Bight and off Port Royal bear all three species. The mangrove vegetation can be divided into three groups: (*a*) reef mangroves with roots in the holes and crevices of the boulders; (*b*) mud mangroves occurring at the mouths of estuaries; and (*c*) sand mangroves growing on the sand cays and sand spits. Those in group (*a*) play no part in the

Fig. 3.
PNEUMATOPHORES OF *Avicennia nitida*.

formation of new land, but those in group (*c*) may spread and unite several small sand cays or ridges and so produce one large swamp. This has undoubtedly occurred along the inner edge of the Palisadoes and is taking place to-day in the Bogue islands near Montego Bay.

As the tidal range in Jamaica is very small, any zonation of the different mangroves is not easy to distinguish. In protected bays, on the leeward side of cays, and along rivers, *Rhizophora* forms a narrow outer fringe with *Avicennia* behind, whilst *Laguncularia* tends to mix in with the *Avicennia* when the ground becomes slightly higher and drier. In exposed sand-spit areas, however, *Laguncularia* forms the outer fringe with *Avicennia* behind, whilst *Rhizophora* is confined to the damper pools and depressions. Ultimately the mangrove vegetation yields to dune, salina, or freshwater swamp, depending on the local conditions. The most active production of new land by mangroves is taking place at the mouths of rivers, but even in some of these localities exposure to wave action has occasionally brought about an onset of erosion. In such places old mangroves lie uprooted in front of the protecting ridge, whilst seedlings never have an opportunity to establish themselves. In other places where there is very little mud or sand deposition the mangroves produce a marine peat, but it is evident that the formation of new land by this method must take an extremely long time; in the end it results in a much more solid substrate than is normally associated with mangroves.

Particular attention was paid to the ecology of *Avicennia nitida* and the functions of its pneumatophores (Fig. 3). The tides around Jamaica permit of one major (nine inches to one foot) and one minor (three to five inches) tide a day, and observations showed that only the major tide covered the soil in much of the swamps. In addition to this diurnal fluctuation there were the spring tidal cycles, and it was evident that in some of the swamps quite a number of days could elapse between two floodings. It was also established that *Avicennia* grew on three distinct types of soil: (*a*) sandy soil; (*b*) muddy soil; (*c*) peat. The oxygen content of the soil water was very low, ranging from 0 to 0·26 per cent, and although bubbles of gas could be obtained from most positions within a swamp, upon analysis such gas always yielded a low oxygen value, the average being about 7 to 8 per cent. This is very different from the concentration in the atmosphere, and it is probably insufficient for the respiratory metabolism of the lateral roots. Analyses of the gas contained in the pneumatophores and lateral roots showed that it was not very different from that of the atmosphere so far as the oxygen and carbon dioxide content were concerned. This means that the pneumatophores must form a channel for gaseous interchange. Whenever parts of the pneumatophores were below the soil surface they bore slender horizontal rootlets at a depth of about 1 cm. If, however, the whole of the pneumatophore was exposed, as, for example, when the lateral roots crept among the boulders or were exposed upon the beach, the horizontal rootlets would be absent or else growing out directly from the lateral roots. These are evidently the absorbing organs, and normally they develop from the pneumatophores. Some evidence was also obtained to show that, whilst not primarily organs of respiration, nevertheless the pneumatophores do exhibit some respiratory activity.

The zoologists, Mr. Colman and Mr. Crisp, spent most of their time collecting for the British Museum, one of the more interesting finds being *Littorina minima*, of which only three specimens have previously been known. Three level-traverses were made across well-vegetated beach-rock and from one of these, which exhibited excellent algal zonation, samples of the flora were also taken. A tide gauge was established at Port Royal and from the records obtained it is hoped to secure some data about the relative positions of the different animals and plants in relation to tide-levels. T. A. Stephenson and his school have shown that on the South African coast, where the tidal range is comparable to that at Plymouth, systematically related animals tend to occupy the same ecological positions as at Plymouth. It therefore seemed worth while to compare with these two places the corresponding distribution in the Caribbean where the range of tide is very small. It soon became evident that there is, on the whole, a remarkable paucity of living coral around the cays, especially the Morant cays, and this is striking because in similar places off the Queensland coast masses of coral would be encountered. At present there seems to be no adequate explanation of this feature, but it is clear that the cays and reefs are not coral in any full sense of the term. The general conclusion is that the Jamaican marine fauna, though varied, is, nevertheless, somewhat scanty.

Very little can be recorded about the activities of the forest party because the collections, which have been left in Jamaica for safety, have yet to be examined. Dr. Thomas collected much material of the monotypic genus *Rhipidopteris peltata* and also of the genus *Elaphoglossum*, both of which are imperfectly known. Messrs. Philipson and Sporne, apart from collecting for their own purposes, secured a collection of wood specimens for the Imperial Bureau of Forestry at Oxford.

TREE RINGS AND CULTURES IN THE SOUTH-WESTERN UNITED STATES

DENDROLOGICAL evidence, in other words the tree-ring method of dating as applied to the archæological investigation of early cultural remains in the south-western United States, not only confirms, and is itself confirmed by, stratigraphical evidence, but also serves to afford a clue to at least one among the causes which may have contributed to bringing about fundamental changes in mode of life of south-western peoples, and even the decay of a flourishing civilization. It has, for example, long been an open question among American archæologists why a people living in small scattered villages should develop a tendency to concentrate in urban communities, which later become the great communal houses of the Pueblo period; and further, why this Pueblo civilization, on attaining a remarkable peak-point in development, should suffer a serious decline, and many settlements be abandoned. At neither point does there appear to be any significant fluctuation in numbers of the population, nor any serious increase in raiding activity of hostile tribes.

It is pointed out by Dr. F. H. H. Roberts, jun.[1], in a survey of current archæological knowledge of the south-west, that both these crises coincide with periods of drought indicated by the tree-ring sequence, while the period of greatest expansion in Pueblo civilization is also a twenty-year period of favourable conditions.

In introducing this report on his archæological investigations in eastern Arizona, Dr. Roberts advances arguments for a new classification and nomenclature in south-western archæology, to supersede that adopted at a conference held at Pecos in 1927. It was then decided to accept a discrimination in the Basket Maker culture, at that time the earliest differentiated in the south-west, into three stages, and of the Pueblo cultures into five, of which the latest stages were post-Columbian and extended to modern times. Yet, as Dr. Roberts points out, Basket Maker I, the primary stage of a simple nomadic hunting people, leading up to the semi-hunting, semi-agricultural phase of the later Basket Maker culture, is entirely hypothetical, and no relics which can be assigned to it have been discovered. Hence he suggests its elimination, and the substitution of 'Basket Maker' simply for the second stage, the earliest known at present, and 'Developed Basket Maker' for stage III. Pueblo I and II become 'Developmental Pueblo', while Pueblo III–V are covered by Great Pueblo, the period of greatest expansion, 'Regressive Pueblo', the period of decline, 'Renaissance Pueblo' and 'Historic Pueblo', as more truly in consonance with the history of the development of the culture.

Further, in considering the character of the earliest period, Dr. Roberts distinguishes three types of culture—two major provinces, to which he now adds a third. Of these the first centres in the plateau country of the area comprised in the States of New Mexico, Arizona, south-west Colorado, Utah, eastern Nevada, western Texas, and northern Mexico. For this the name 'Anasazi' is proposed. The second is the culture of the desert precincts and lowlands, to which the name 'Hohokam' is applied, while a third province, hitherto considered a variant of Anasazi, is the 'Mogollon', which centres in San Francisco and the Mimbres River valley in south-west New Mexico.

The main differences between the Anasazi and Hohokam cultures summarily stated are as follows: While the Hohokam practised cremation, the Anasazi buried their dead. The Hohokam built rectangular, single-unit houses of pole, brush, and plaster construction, while the Anasazi progressed from circular, or rectangular, single-unit dwellings of poles, brush, and plaster to multi-storied communal houses of stone. The Hohokam progressed from flood-water irrigation to an extensive canal system for watering their crops; but the Anasazi depended mainly on flood-water, though in some sections they employed small ditches. Both used coiled pottery, but their finishing processes differed, as did the decoration, the Anasazi developing from black to polychrome, while the Hohokam used red on buff.

The Mogollon cultural pattern is that of a sedentary agricultural-hunting complex, in which the hunting aspect is more pronounced than in either Anasazi or Hohokam. As a rule, the dead were buried, but there was some cremation. Houses were rounded and semi-subterranean, followed by rectangular semi-subterranean, and then by the Pueblo type.

While dendrological evidence is available for dating the Anasazi culture, the varieties of timber used in house construction in the Hohokam culture is not adaptable to tree-ring studies; and the determination of period in Hohokam must depend upon pottery types and reference to trade objects of the Anasazi penetration until A.D. 1000, when

Anasazi settlement took place in the Hohokam province. Timbers from the Mogollon houses have been dated, making correlation with Anasazi possible. It is suggested that basic Mogollon, not yet clearly defined, was contemporary with Modified Basket Maker, and its later stages of development with Developmental Pueblo, Great Pueblo, and Renaissance.

Investigation of the relations of the Mogollon culture to various phases of Anasazi, both Basket Maker and Pueblo, have been in progress throughout the summer of 1939: at Glenwood, New Mexico (Field Museum of Natural History, Chicago); a second expedition working also near Glenwood (Logan Museum); and on a village site occupied A.D. 700–800, south of Showlow, Arizona (Arizona State Museum).

[1] *Smithsonian Inst.: Bur. Amer. Ethnol. Bull.*, 121 (1939).

OBITUARIES

Prof. H. H. Meyer

THE death of Hans Horst Meyer on October 6 severs perhaps the last direct link with the beginnings of experimental pharmacology as a separate science.

Meyer was born on March 17, 1853, in Insterburg in East Prussia, and studied medicine at Konigsberg, Leipzig and Berlin. A story goes that he passed his qualifying examination in all subjects except pharmacology and that it was to rectify this defect that he undertook an investigation under Jaffe, which gave him an introduction to the technique and literature of experimental physiology. Later he went to Strassburg to work under Schmiedeberg, as did nearly all the prospective pharmacologists of the time, and had just been appointed assistant to Schmiedeberg when he was called to Dorpat in 1881. Here he succeeded Boehm, the immediate successor of Buchheim, who had established in Dorpat the first laboratory for experimental pharmacology. In 1884 he became professor at Marburg where he worked for twenty years, after which, in 1904, he became director of the Pharmacological Institute in Vienna. He held this appointment for another twenty years, retiring in 1924. Still active, he was put in charge of a department for standardization of drugs, an appointment to which there was no age-limit and accommodation for which was given in his old laboratory. Up to a year or two ago, he still held every month in his own house a discussion on some pharmacological problem, which all the workers in the Pharmacological Institute, including his successor Pick, attended, and I am informed by one of the staff that up to the end Meyer took a leading part in these discussions, with little impairment of his enthusiasm or of the constructive and critical acuity of his mind.

Like most of the pharmacologists of his time, Meyer was no narrow specialist. His investigations ranged over a wide field, and behind it all was the desire to link up pharmacology with general biology and pathology on one hand and the treatment of disease on the other, towards the establishment of a more rational therapy. His influence is to be measured not only by his achievement but also by the vision which prompted it and by his guiding example of the lines upon which pharmacological investigation could be profitably pursued. Among the pharmacological problems he investigated were the action of the alkaloids of jaborandi and corydalis, acute poisoning with phosphorus and with metals, especially iron and bismuth, and the action of purgatives and astringents. He also did some pioneer work on the reaction of the blood, on heat-regulation and on the action of diuretics and, resulting perhaps from his early work on jaborandi, he was especially interested in the development of the knowledge of the autonomic nervous system.

Meyer's claim to a permanent place in the history of pharmacology will, however, probably rest upon his contributions to two problems which lay outside the range of routine descriptive pharmacology. The first of these was his theory of the action of narcotics; he sought to explain their action by their relatively greater solubility in lipoids than in water, which led to their accumulation in the cells of the central nervous system with a consequent suspension of nervous activity.

This theory, which was independently and almost simultaneously suggested by Overton, has required subsequent modification, but its importance lies in its being a pioneer attempt, based upon experimental evidence, to solve one of the fundamental problems of pharmacology—the chemical or physical basis for the site and quality of pharmacological action. The other problem to which he introduced new conceptions was the action of bacterial toxins. Especially will be remembered his suggestion that tetanus toxin travels to the central nervous system by way of the motor nerves rather than by the blood stream. He also showed that antitoxins were the more effective the earlier they were given, and were relatively inefficaceous once the toxin had combined with the tissues.

Apart from his own work, Meyer profoundly influenced, by his wide knowledge and imaginative power, those who went to work with him from different parts of the world. His scientific eminence was recognized by many universities and learned societies outside his own country. He was the senior surviving honorary fellow of the British Physiological Society and, with J. J. Abel, was the first honorary member of the British Pharmacological Society.

J. A. GUNN.

Dr. E. P. Poulton

EDWARD PALMER POULTON, who died on October 18, was the eldest son of Sir Edward Poulton. He was born at Oxford in 1883, and educated at the Dragon School, Oxford, and at Rugby; in 1902 he obtained the Brackenbury Scholarship in natural science at Balliol College, Oxford. After taking the First M.B. he read Chemistry Finals.

Poulton went to Guy's Hospital for his clinical work in 1907 and qualified B.M. (Oxon.) in 1910. After appointment as house physician, he won the Radcliffe Travelling Fellowship and worked in Germany. His early scientific work (1912–14) was mostly on the metabolism of uric acid and of creatin and creatinin.

In 1914 Poulton was appointed assistant physician to Guy's Hospital, and he became interested in the chemical side of diabetes, working on the value of alveolar air determinations as a measure of the acidosis and also writing on the value of starvation in the treatment of diabetes. The introduction of insulin in 1922 intensified his interest in diabetes, and his main clinical work continued to be with diabetic patients.

In 1920 he was elected to a Beit Memorial Research fellowship. At an early stage he had worked with Haldane on the effects of want of oxygen on respiration, and this influenced the direction of much of his later work. From 1918 until 1925, with a series of pupils, Debenham, Joffe, Campbell, Parsons, and later Spurrell and Warner, he was working continually on the problem of dyspnœa in connexion with the oxygen and carbon dioxide carriers in the blood, and with its hydrogen ion concentration and with the oxyhæmoglobin curve. For a time at Guy's Hospital an oxygen chamber was installed where patients could live in an atmosphere of, say, 40 per cent oxygen, and the influence of this on their disease and on their physiological processes could be observed. He was satisfied that many patients with chronic bronchitis and heart disease obtained benefit from this treatment, and this was the foundation of his belief in oxygen therapy which became the main interest of his later years.

Another early interest to which Poulton returned again was the problems of pain in gastric ulcer and of pain and of normal sensation in the œsophagus. He carried out investigations on himself and others by introducing into the œsophagus a balloon which could be distended while the subject was under X-ray examination. In 1928 he gave the Oliver-Sharpey Lectures, dealing with the experimental study of certain visceral sensations, and the next year published a paper in the *Guy's Hospital Reports* on the physiological considerations underlying abdominal pain.

The mechanical side of any investigation always made a great appeal to Poulton, and much of his later work was concerned with the development of apparatus, for example, positive pressure machines and oxygen tents. Although often rather complicated in appearance, his oxygen tent in its final form was a neat and beautiful piece of apparatus. His enthusiasm for oxygen therapy has no doubt been one of the factors leading to the increased use of this treatment; latterly his enthusiasm led him to start experimental observations on patients with such diverse conditions as rheumatic carditis and cerebral hæmorrhage.

Apart from the many published papers on the subjects mentioned, Poulton published two books, "Oxygen and Carbon Dioxide Therapy" with Argyll Campbell, and "Diets and Recipes and Treatment of Diabetes and Obesity". He also acted as editor of the 12th to 14th editions of "Taylor's Practice of Medicine", the first of these in 1922. This was perhaps his greatest contribution to medical teaching; he devoted much time and trouble to the preparation of each edition, so that this old text-book was made a good practical guide and kept remarkably up to date.

Poulton was chairman of the International Society of Medical Hydrology, and in 1937 was president of Section I (Physiology) of the British Association—an unusual distinction for a practising physician. He was also greatly interested in the work of the League of Nations Union and spent much time on this.

There were many qualities, including his wholehearted enthusiasm and his charm and kindliness, which endeared him to his many friends. Although he knew his heart was affected, his regular hospital duties and teaching, his research work and writing, and his many societies and meetings, show how little he let this stand in the way, and in their multifarious activities he never spared himself.

In 1911 Poulton had married Elfrida, youngest daughter of Mr. Charles Maclean of Glenearn, Perthshire, and had three sons and two daughters. His eldest son has recently qualified and is now a medical officer at Pembury, the second is in the Army, and the third a medical student. M. CAMPBELL.

Major A. E. Levin

WE regret to announce the death of Major Arthur Everard Levin, which took place on November 8 after a short illness. Levin was born on February 17, 1872, and was educated privately. He took up electrical engineering as a profession and enlisted in the Royal Engineers on the outbreak of the South African War. For some time after the conclusion of that war he held a Government appointment and later was associated with the firm of Mordey and Dawbarn, consulting electrical engineers, retiring from his profession in 1928. He remained with the old 'Volunteers' when they became 'Territorials' and was called up for service on August 5, 1914. Later he was placed in command of the first Electrical and Mechanical Company to be sent to France, and was mentioned in dispatches in April 1918. He saw service in Italy in the same year.

After demobilization, Levin's interests turned to astronomy. In 1919 he was elected a member of the British Astronomical Association and in 1921 a fellow of the Royal Astronomical Society. His work in astronomy was mainly connected with computations.

He was the second director of the Computing Section of the British Astronomical Association, formed in the 1920–21 session, a position which he held with only one or two minor interruptions until 1938. The annual production of the "Handbook" required much time and patience, especially with computers who had to be initiated into the subtleties of the calculations essential for the work. Levin displayed a wonderful amount of tact and judgment in teaching new computers, and his unfailing courtesy and kindness will never be forgotten by those who could always turn to him for advice and guidance.

The "Handbook" is used at many of the great observatories for the information that it supplies on various branches, not least that dealing with the ephemerides of comets, for which the perturbations by the major planets have been computed. In this connexion reference may be made to the last great computational work that Levin undertook, in collaboration with Mr. J. G. Porter, his successor as director of the Computing Section. This was the computation of the perturbations of the planets on Comet Pons-Winnecke for two revolutions, Cowell's method being used for the greater portion of the work. The comet was found almost exactly in its predicted position by van Biesbroeck, an indication of the accuracy of the calculations. Levin made a speciality of the mutual eclipses and occultations of Jupiter's satellites, and a full description of his method of prediction appeared in the *Memoirs of the British Astronomical Association*, **30**, 3, December 1934. He was elected president of the Association for the sessions 1930–32 and proved himself a very popular and efficient officer.

It is characteristic of Levin's love for astronomy that he presented his 4-inch refractor to the Association this year, and he has also left all his astronomical books and his 6-inch telescope and observatory, now at Selsey, to the Association. He leaves a widow and one son, the latter serving in the Navy.

Dr. G. D. Lander

GEORGE DRUCE LANDER, who died on October 25, aged sixty-five, was a man with a strong personality and a chemist whose work was characterized by breadth of outlook and soundness of judgment.

Lander studied chemistry at the Royal College of Science and Birkbeck Institution, London. After working with Japp in Aberdeen on the synthesis of pentacarbon rings, he proceeded to St. Andrews, where he assisted Purdie in his researches in stereochemistry. Purdie and Lander observed that the product obtained by the action of ethyl iodide on the silver salt of optically active lactic acid possessed a higher rotation than ethyl lactate prepared by the usual esterification process, and they suspected that the higher value was due to the presence of a small amount of the ethoxy derivative. This and similar observations led Purdie and his associates to devise the silver oxide – alkyl iodide method of alkylation, a reaction which afterwards proved to be the most serviceable tool in the hands of organic chemists of the St. Andrews and Birmingham Schools for the controlled degradation of carbohydrates. At University College, Nottingham, Lander made a study of the chemistry of imino-ethers, and in 1903 he was appointed to the chair of chemistry and toxicology at the Royal Veterinary College, London.

In order to deal satisfactorily with the increasing number of cases of suspected poisoning among animals on which he was consulted, Lander found it necessary to make a comprehensive experimental survey of the methods for the detection of mineral and other poisons. Some results of this work were published in communications to the *Analyst*. Circumstances also arose which led him to investigate the separation and identification of very minute amounts of alkaloidal drugs, and a short paper entitled "Microanalysis of Alkaloids" was afterwards published in the *Analyst*. His skill in manipulation contributed to his success in this field, in which he was actively interested for the remainder of his life.

Lander retired from the Royal Veterinary College in 1920. The well-known "Systematic Inorganic Chemistry" by Caven and Lander was published in 1906, and Lander's "Veterinary Toxicology" in 1913. Lander was a member of the Court of Governors of Birkbeck College for some years, and an examiner in chemistry and toxicology for the Royal College of Veterinary Surgeons from 1923 until 1939. After his retirement from teaching he resided at Tenterden, Kent, and devoted much time to the municipal affairs of that ancient borough. He leaves a widow, who gave him much assistance in his analytical work.

G. W. CLOUGH.

WE regret to announce the following deaths:

Dr. William H. Brown, lecturer in botany in the Johns Hopkins University, formerly director of the Bureau of Science at Manila, on November 9, aged fifty-five years.

Dr. Livingston Farrand, emeritus president of Cornell University, formerly professor of anthropology in Columbia University, on November 8, aged seventy-two years.

Prof. E. A. Gardner, emeritus professor of classical archæology in the University of London, on November 27, aged seventy-seven years.

Prof. Waldemar Lindgren, formerly professor of geology in the Massachusetts Institute of Technology, on November 3, aged seventy-nine years.

Prof. F. K. Richtmyer, professor of physics in Cornell University, on November 7, aged fifty-eight years.

Mr. A. A. Simpson, C.M.G., C.B.E., president of the Royal Geographical Society of Australasia, well known for his explorations in Australia, on November 27, aged sixty-four years.

Prof. Charles Vaillant, formerly director of the X-Ray Departments in the Baudeloque Clinic and the Lariboisière Hospital, one of the most eminent X-ray pioneers, on December 4, aged seventy-seven years.

NEWS AND VIEWS

Science and Censorship

THE so-called magnetic mine and the device recently used by Germany for laying mines at sea by means of aircraft are reminders—if such reminders are necessary—of the increasing use which is being made in warfare of recent research and invention. This must not be placed either to the credit or debit side of the balance sheet of science. Very few indeed of the scientific developments now being widely used in the present war are the outcome of research directed towards their present purposes; rather they are adaptations of results obtained by men of science in their inquiries into natural phenomena, and many of them have a history of much useful service to mankind before their powers for destruction were utilized. Scientific curiosity, the urge to know how and why things work, must never be stifled; and in time of war, this is especially true. It is all the more regrettable, therefore, that the powers that be neglect to release information which would satisfy the curiosity of scientific workers. Speculative articles in the lay press carry little conviction; it should not be unduly difficult to keep men of science informed of the general principles of so-called new weapons without giving information to the enemy; this would do much towards allaying the doubts aroused by official silence. As was pointed out in the leading article in NATURE of October 14: "In the fighting services themselves the methods of defence and offence are largely scientific. Some of these methods are highly secret; others are well known to the enemy. There could be no conceivable harm, and there might be great good, in informing the public freely of the latter. . . . The present danger is that everything scientific may be censored, even laws of Nature." Publication of scientific facts already well known to the enemy—for example, the structure of various of his own instruments captured in action or otherwise recovered—would prove not merely of interest to men of science but also probably of the utmost value in forming the topic of scientific discussion.

Invasion of Finland

EARLY this year, Czechoslovakia was lost to democracy by the action of Germany; last September, Poland was invaded and very shortly afterwards divided between Germany and the U.S.S.R. Now Finland has been attacked by the U.S.S.R. The methods adopted by the aggressors, German and Russian, have been similar in each case. These two dictatorships are making a determined onslaught on smaller and independent States, and all who value freedom of thought and other democratic institutions will regard their actions with abhorrence. Finland, as a separate State, is young in years, but her people have already established for themselves a reputation for enterprise and industry. A considerable export trade in timber, wood-pulp and butter has been built up, and the country also possesses valuable nickel deposits which were being developed. Helsinki, the capital, has an ancient university and a technical institution. Readers of NATURE will recall several communications in these columns from Prof. A. I. Virtanen and colleagues, of the Biochemical Institute, Helsinki, describing work on chemical aspects of the biological fixation of nitrogen, while Dr. P. Suomalainen has recorded work on changes in the blood which occur in hibernating animals. It is also of interest to note that M. Pekkala, finance minister in the new Government formed immediately after the invasion of Finland, is director of the State Forest Institute.

Science and Political Theory under the Soviets

A LITTLE while ago archæologists and students of the prehistory of the Eurasiatic continental tract received with profound regret and no little dismay the news that no further numbers of *Eurasia Septentrionalis Antiqua* would be published. This much-valued archæological periodical has been issued under the auspices of the Finnish Archæological Society and edited by A. M. Tallgren, professor of archæology in the University of Helsinki. Founded by Prof. Tallgren himself, it has contained in the twelve volumes of its issue many notable contributions to archæological science in its special field, the prehistory of European and Asiatic Russia and adjacent regions, by archæologists of world-wide reputation; but its mainstay has been the work of its editor, Prof. Tallgren himself, who has devoted more than thirty years to this subject. It was his constant aim, however, to advance knowledge in this field by synthetic study of the broader problems, rather than by specialized research; and for this purpose it has been necessary for him to seek international co-operation both by way of comparative study and for constant reference to, and verification from, original material in museums and collections. This assistance has been given freely. Prof. Tallgren modestly attributes the success of *Eurasia* to the collaboration of more than a hundred archæologists in Europe and the United States. He personally, for his own special studies, has relied to no little degree upon the help of his Russian colleagues; but for some time past he has received no periodicals from Russia, and his letters and inquiries addressed to Russian archæologists have remained unanswered. The failure of this essential source of information and the absence of collaboration from this field of investigation leave so many gaps and uncertainties in Prof. Tallgren's studies that with profound reluctance he has come to the conclusion that his work, and with it the publication of *Eurasia*, must come to an end.

IN making this announcement, Prof. Tallgren does no more than glance at underlying causes when he refers to the possibility of harming an individual in

his own country even by commendation. Under the Soviets, the imposition of Marxist doctrine on archæological theory has constrained research workers, members of the staffs of archæological museums, and teachers in universities and higher schools to subscribe to a particular theory of cultural development, in which emphasis is laid on economics to the exclusion of all other influences bearing on the development of peoples. The enforcement of this political doctrine on scientific teaching and research has fixed a gulf between the Russian archæologist and his Western colleagues, and the Soviet political dictatorship is evidently determined that it shall be completely effective against Western archæological thought, which in taking a broader view is accused of interest only in the study of the exploiters of the proletariat. Hence the Russian archæologist must be guarded against the views of those who, for example, attach weight to the influence of migration. Those who do not conform implicitly to this frustration and perversion of the spirit of science and the aim of research, or such variation of it as may occur to Soviet rulers from time to time, have been removed from the performance of their duties, while some have vanished, leaving no trace.

Prof. D. H. Campbell

ON December 16, Prof. Douglas H. Campbell, emeritus professor of botany in Stanford University, California, will attain his eightieth birthday. His repeated presence as a foreign guest at meetings of the British Association has passed him almost as one of ourselves. His many friends among British botanists will wish to congratulate him on carrying as a light burden his tale of years. The nature and extent of his researches brought him early into prominence. Having learned Continental methods of research in the laboratory of Kny, his own fine memoir on the Ostrich fern (1887) opened that long series of researches, the results of which he compressed into the well-known volume on "Mosses and Ferns" (1895). This book ran into its third edition in 1918. In point of detailed observation of archegoniate plants, and particularly of their development, Campbell thus proved himself a most prolific observer.

BUT the scientific stature of an investigator is not so truly measured by the volume of his output as by the acceptance of his conclusions, and their passage into the web of his subject. In January 1890, in a short memoir on "The Affinities of the Filicineæ", Campbell introduced a new aspect into the problem with which it dealt. In opposition to the views then current, he held that the relatively massive eusporangiate ferns were primitive types, while the more delicate Leptosporangiatæ were derivative. By thus inverting the current evolutionary sequence, he provided a more probable key than this to the origin of a vascular flora of the land. Others at once saw the cogency of Campbell's reasoning, while palæontology rapidly supplied its own essential substage of fact. His view was confirmed later by his own treatise on the Eusporangiatæ (1911). When we consider the early date of Campbell's first statement, his generalization takes a high place in the history of comparative morphology.

PROF. CAMPBELL has been a great traveller in quest of material for research. Latterly he has assembled his impressions and conclusions into "An Outline of Plant Geography" (1926). With modesty he offers his volume, though he confesses in the preface that he can scarcely claim rank as a plant geographer. We may gratefully receive these collected impressions of a first-class observer. As a water-colour artist he has also been able to record pictorially much that he has seen. His sketches form a counterpoise to the vast number of his detailed drawings of plant-structure and development, so many of which have been borrowed for use in current texts.

Rights and Duties of Science

IN an article "Rights and Duties of Science" in the *Manchester School* of October 1939, Prof. M. Polanyi examines the Marxist claims, and particularly those of Prof. J. D. Bernal in "The Social Function of Science", for a radical reconsideration and readjustment of the duties of science, and of the assurances accompanying these claims that they will not impair the vital rights of science. The main points at issue are comprised in the relation of pure and applied science. A distinction between these is not admitted in Marxism, which attributes such a distinction in capitalist countries to the inner conflict of a type of society which deprives men of science of the consciousness of their social functions. Stating the liberal view of the distinction between pure and applied science, and concerning the relation of science and society, Prof. Polanyi points out that, to the liberal, science represents in the first place a body of valid ideas. Science consists of autonomous branches, ruled by their several systems of ideas, and these systems have proved permanent while waves of civilization have come and gone. In a shifting world the mind clings persistently to the rare structures of sound and consistent ideas, and in these structures all scientific interest resides.

THE direct appeal of a subject does not in itself signify scientific interest. Prof. Polanyi emphasizes the mutual reactions between science and practical knowledge, and urges that attempts to direct research towards results of possible practical applicability cannot lead to a growth of science that is of much value. A consistent policy on these lines would stop the development of science altogether, turning in effect the efforts now directed to scientific research into attempts to discover empirical solutions for practical problems. Prof. Polanyi condemns, for example, cancer research, and urges that all progress depends on the freedom of the systematic branches of science to pursue their own specific scientific aims. Universal adoption of a policy of endowing research for practical aims would bring science to a standstill and gradually exhaust its practical applications.

SOCIETY, in the liberal view, cultivates science as an organism of ideas which powerfully attracts the minds of intelligent people, and also to increase the store of knowledge available for practical application. This position of science in society is a significant example of the principles of liberty, being indeed merely a special feature of the position of thought in society. Freedom is not only possible but also a social necessity when we admit that the realm of thought possesses its own life. Prof. Polanyi dissents from Prof. Bernal's desire to put science into the consciously organized service of human welfare, arguing that the new attitude leads to the approval of oppression of intellectual liberty, if it is perpetrated only in pursuit of approved political aims. Prof. Polanyi is on firm ground in criticizing a somewhat propagandist attitude in regard to Soviet Russia, but his sincere plea for the re-establishment of man's right to pursue truth regardless of social interests would have more reality if he would recognize the present lopsidedness of scientific development. The reorientation of scientific effort for which so many scientific workers are calling involves no threat to fundamental research, which, indeed, it is desired to instigate in fields at present neglected.

Weather Reports in the United States

ACCORDING to a report which has been issued by Science Service, the United States Weather Bureau is making the experiment of having both aviation forecasts and general forecasts not specially suited to the requirements of aviation made by a single staff, in the case of the new district office of the Weather Bureau at Kansas City airport. Up to now, aviation forecasts have been made by special staffs at airports, while the other forecasts were made independently at Weather Bureau offices located in the different towns. If this experiment, which began on October 1, proves successful, it is intended to extend it to other stations of the Weather Bureau. The Kansas City district office programme includes also a new feature that has recently been introduced at Washington and Baltimore and which has proved very popular, namely, a 'breakfast time' broadcast forecast. It is expected that this will be extended to many other American cities in the near future. It is not stated what time is taken as 'breakfast time' for the purpose of these broadcasts, but presumably it is too late to make the forecasts meet the requirements of farmers, who must arrange what work shall be done during the day at an early hour and could only take account of correspondingly early forecasts. There was before the War a demand by British farmers for such 'pre-breakfast' forecasts; but an obstacle in the way of their realization is that an hour or two must elapse between the taking of the observations on which the forecasts must be based and the time at which they are made, to allow the information to be collected, decoded, charted and critically examined, and a very large number of observers would have to begin their day's work at about 4 a.m.

Penetration of the Skin by Heat

IN a paper entitled "The Penetration of Rays through the Skin, and Radiant Energy for the Treatment of Wounds", read before the Royal Society of Arts on November 22, Sir Leonard Hill gave a useful review of our knowledge of the extent to which luminous, thermal and other radiations can penetrate the skin. He also referred to some of his own recent work on the differences in the penetrating power of heat radiation according to the nature of its source. Experiments on the production of artificial fever by means of short-wave oscillators show that the body temperature can be raised to 105°–106° F. in an hour or so.

WITH what some of his listeners may have thought a curious irrelevance to the subject, Sir Leonard delivered himself of a judgment about radium treatment, to wit "The world would, I think, be little the worse off if all the radium in the country now buried for security from bombing in deep holes, remained therein. Very big monetary influences will cry out against this". The question may well be asked whether Sir Leonard really believes that these monetary influences determine the practice of radium therapy in Great Britain. About 15,000 patients received such treatment in 1938. Are the results of so little value to cancer and other patients that Sir Leonard's advice should be taken on this subject? The Cancer Act is the country's reply to such a question.

Quantitative Estimates of Sensory Events

THE final report of the committee appointed to consider and report upon the possibility of quantitative estimates of sensory events has appeared (Sections A and J, British Association, Dundee, 1939). This committee was appointed in 1932 after Sections A and J of the British Association had held a joint session dealing with the problem. It has been re-appointed each year since. In 1938 a long interim report was presented containing: (*a*) a historical statement; a summary of recent experimental work; (*b*) a statement arguing that sensation intensities are not measurable; (*c*) various notes on this statement; (*d*) a statement arguing that sensation intensities are measurable. A subcommittee was appointed to consider whether the views put forward were really irreconcilable. This subcommittee presented a draft report to the British Association this year. It now seems that agreement is impossible. This is scarcely surprising when there is disagreement as to the meaning of 'measurement'. If it is postulated that this term must be limited to its applicability in physics, then this would rule out the use of the word in relation to much psychological work. Two extreme views hold the field, and a close examination of these views by a member who holds an intermediate view leads to the conclusion that they cannot be reconciled. The report therefore consists of the views of individual members. The discussion is of value, even apart from the data here presented, as illustrating some of the difficulties inherent in such problems.

Royal Gardens of Queen Anne

A NUMBER of interesting manuscripts belonging to Lieut.-Colonel H. E. Disbrowe-Wise have lately been abstracted by Mr. F. J. Chittenden (*J. Roy. Hort. Soc.*, **64**, Pt. 10; October 1939). They relate to the part played by Henry Wise in the upkeep and re-arrangement of the Royal Gardens in the reign of Queen Anne. Wise and his partner, George London, were the proprietors of the great Brompton Nursery, and directed the establishment of most of the large gardens of England at the beginning of the eighteenth century. They were responsible for the introduction of French influence in garden design, but they evidently eliminated some of the frivolities of Versailles horticulture, and used only the stateliest elements in the spacious parks, terraces and avenues of Hampton Court and other Royal demesnes. Details and costs of the upkeep are revealed by the manuscripts. Henry Wise received £1,600 a year from 1702, for the upkeep of Hampton Court, the gardens at Windsor and the plantations at Kensington. A catalogue of the varieties of wall fruit reveals some affinity with modern names, and an important side of garden activity is shown by a description of five new pears which bore fruit in the year 1715. Each of the new varieties appears to have been "very rich and melting", and doubtless played its part in the general improvement the results of which we enjoy to-day.

National Central Library

WINTER is the reading man's season. Then, as the Student says in Goethe's "Faust":

> "the pleasures of the mind
> Bear us from book to book, from page to page.
> With them the winter nights grow kind and bright,
> And every limb is warmed with happy life."

But if we want unusual books, such as, say, Bolingbroke's idea of a "Patriot King", can we get them? The answer is given by the great National Central Library in Malet Place, London. It lends books through the local libraries and regional bureaux and has access to 21 million volumes in other institutions. It can do work of national importance in helping research in science and medicine. Some irreplaceable matter has been removed to Hemel Hempstead, but the non-bibliographical books remain at the London headquarters. The latest report of the Library shows that it lent during 1938–39 more than 21,000 books to urban libraries, and more than 12,000 to country ones. The 'outlier' libraries, from which readers can borrow through the National Central Agency, now include, we notice, the British Postgraduate Medical School and the Library of Radiological Periodicals (Dr. Bernard Leggett).

Health in British India during 1937

THE state of the public health in British India and some of the Indian States during 1937 is dealt with in the recently issued "Annual Report of the Public Health Commissioner with the Government of India for 1937" (Government of India Press, New Delhi, 1939. Price Rs. 3 or 5*s*.). The mid-year estimated population for British India was 272,406,436, an increase of more than three and a quarter millions compared with the previous year. The birth-rate was 34·5, and the death-rate 22·4 per mille, each a slight decrease over the previous year, and the infantile death-rate per 1,000 live births was 161·7. Plague mortality, with 28,169 deaths, was appreciably higher than in 1936, but deaths due to cholera and smallpox, 99,054 and 54,810 respectively, showed large decreases, so that there was a total reduction of more than 90,000 deaths from these epidemic diseases. With regard to plague, it is remarked that within recent years the fatality-rate has considerably decreased, and that the disease is often so mild that patients remain at work during the attack. Malaria and respiratory diseases cause the largest mortality; roughly about 1,000 people die from malaria every day throughout the year. Dysentery and diarrhœa caused 267,479 deaths, or more than two and a half times the number of cholera deaths. With regard to vaccination and its protective power against smallpox, figures show that the greater the number of vaccination 'marks' the smaller is the case mortality rate, and that mortality is much the highest among those having 'no marks', which may be presumed to mean absence of vaccination. The volume also contains much information on maternity and child welfare and on the research work of various colleges and institutes.

Animal Welfare

SINCE 1931 the Universities Federation for Animal Welfare (formerly the University of London Animal Welfare Society) has published annually the Animal Year Book, a journal which has contained many useful hints on the care of animals and given evidence of strenuous propaganda on behalf of the well-being of wild and domesticated animals. The Year Book has now been replaced by *U F A W Quarterly Journal*, which continues the policy of its predecessor but affords means of closer contact between the members of the Federation and others interested in its benevolent activities. Articles of general interest in the first number discuss the ideal pet-shop and a population study of rabbits. A strong and justifiable plea is made for the better regulation of the importation and trade in Mediterranean tortoises, of which some 150,000 are said to be imported into Great Britain annually, often under the most objectionable conditions. It may be added, for the information of readers in whose family circle a tortoise makes its appearance, that pamphlets on the care of these pets have been issued by both the English and Scottish Societies for the Prevention of Cruelty to Animals.

Cave Animals

WITH the appearance of "Pars 14" (published in 1938 but only recently received by NATURE) the great "Animalium Cavernarum Catalogus", compiled by Dr. Benno Wolf and published by Dr. W. Junk, reaches completion. Anyone who has followed the

development of this work must have been astounded at the number of inhabited caves which it revealed, at the extent and variety of cave faunas (the index to the animals itself occupies 96 pages), and at the vast number of papers which have been written about them. The completed work is in three volumes, the first including introduction and bibliography (pp. 108); the second containing a list of the caves, with literature references to each and the names of the animals recorded from each (pp. 616); and the last containing a systematic list of the animals, with references to the caves in which they have been found and to the recorders (pp. 918). The three volumes are thoroughly indexed, one index of 46 pages referring to the caves, the other (96 pp.) to the animals. The bibliography is itself alphabetically arranged so that it serves as a guide to authors. The Supplement carries the information about cave faunas up to the end of 1935.

Work of the Central Midwives Board

THE Central Midwives Board, which controls and regulates the work of practising midwives, has issued its annual report for the year ended March 31, 1939 (H.M. Stationery Office. 4*d*. net). The number of women practising as midwives in England and Wales in 1938 was 16,761, some 700 less than in the previous year. During the year covered by the report, new training and examination rules of the Board came into operation. The training rules require practising midwives to attend courses of instruction from time to time. A report on the examinations held during the year is included, together with notes of various decisions by the Board on midwives' training, etiquette and practice. The report also refers to preparatory arrangements made by the Board for an efficient midwifery service during a national emergency.

Hospital Schools in the United States

SPECIAL educational facilities should obviously be provided for children who must spend weeks, months or even years in a hospital or sanatorium. Some attempt to meet this need has been made in the United States, and information concerning this service has been collected (U.S. Department of the Interior. *Bulletin*, No. 17; 1938). It is estimated that fifty or sixty thousand children in American hospitals need educational facilities, but less than eight thousand appear to be receiving tuition. It is pointed out that the hospital school has three values: therapeutic, vocational and general educational. It aids physical recovery by keeping the child's mind occupied and away from his misfortune.

Bibliography of Seismology

WE have just received vol. 13, No. 1, items 4260–4378 of the Bibliography of Seismology, published by the Dominion Observatory at Ottawa. In this number there are fifteen collaborators from Europe, North America and New Zealand, notable absences being South America and U.S.S.R., where it is known that seismological work is being done. In addition to the particular studies of individual earthquakes, mathematical seismology and general earth structure, a considerable number of the listed papers deal with microseisms and geophysical prospecting. The latter becomes increasingly important as details are worked out and apparatus becomes more applicable to the particular problems involved, needing to be robust, sensitive, and yet transportable. It is noteworthy that item 4342 is of six patents concerned with seismic prospecting, four being U.S. patents, one Canadian and one U.S.S.R.

Seismology in the Antarctic

WE learn from Capt. N. H. Heck that it is proposed to instal a seismograph, if possible on a rock foundation, at a base of the forthcoming United States Expedition to the Antarctic. This, along with the stations in South Africa, South America, Australia and New Zealand will be extremely useful in determining epicentres in the southern hemisphere where seismographic stations are all too few, and on the continent of Antarctica in particular, the seismic history of which is little known. Miss Bellamy's catalogue of 1913–1930 shows seven epicentres actually located on the continent, and the Milne seismograph of the British Antarctic Expedition from March 1902 until November 1903 (lat. 77° 51′ S., long. 166° 45′ E.) recorded 135 earthquakes, of which approximately 75 were local though none was strong enough to be felt by the explorers.

Earthquake in the New Hebrides

ON instrumental reports from the seismographic stations of Georgetown, Tucson, St. Louis, Honolulu, Pittsburg, Manila, Weston, Fordham, Pasadena, Hong Kong, Phu Lien, Apia, Huancayo and Lincoln, the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association has determined the epicentre of the earthquake of October 17, 1939, as having been provisionally in islands of the New Hebrides group in the Pacific Ocean. More precisely, the epicentre was situated in the sea between the islands of Malekula, Ambrim and Pentecost. This is a seismic area particularly liable to deep focus earthquakes, and this shock was no exception, being situated at a depth probably near 100 km.

Royal Academy of the Lincei

THE Secretary of the Royal Academy of Italy announces that the Royal Academy of the Lincei has been amalgamated with the Royal Academy of Italy, which has taken over all the activities of the Lincei. As from July 1, 1939, the publications of the Academy of the Lincei will form part of the combined *Atti della Reale Academia d'Italia*, which will be divided into *Rendiconti* and *Memorie* of the class of moral and historical sciences and of the class of physical, mathematical and natural sciences. The publication of the *Notizie degli Scavi* will be continued without interruption by the Italian Academy. The Royal Academy of Italy will be pleased to send its

publications to those institutions which received the publications of the Royal Academy of the Lincei under a system of exchange.

Chemical Club

THE Chemical Club, 2 Whitehall Court, London, S.W.1, has arranged a series of 'talks' similar to those held at the Club last winter. They will, however, be briefer, and will be held after luncheon in view of the War. The first talk of the season will be given by Mr. James Kewley, chief chemist of the Royal Dutch Shell Group, on Monday, December 11, at 2 o'clock at the Club. The title will be "The Intrusions of Petroleum", and it is expected to deal with the increased range of products being manufactured by the petroleum industry which 'intrude' upon the organic chemical market. At the annual general meeting of the Club on November 14, a resolution was adopted that the facilities of the Club should be thrown open during hostilities, at a nominal subscription, to those temporarily engaged in London on Government work.

Chadwick Public Lectures

IN September last it was decided, in consequence of the War, to postpone the Chadwick Public Lectures which were to have been delivered this autumn. The Trustees have now resolved to resume the lectures, and the first lecture is to be delivered on Tuesday, December 12, at 2.30 p.m., at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, W.1, when Sir William Savage is to speak on "The Health Aspects of Canned Foods". The lectures for the spring programme, 1940, will deal generally with public health matters and the War, and will be announced in due course.

National Institute of Sciences of India

AT a meeting of the Council of the National Institute of Sciences of India, held on October 6 in the rooms of the Royal Asiatic Society of Bengal, Calcutta, the following were elected fellows of the Institute: *Ordinary Fellows:* Dr. K. Banerjee, reader in physics, University of Dacca; Prof. F. R. Bharucha, professor of botany and head of the Department, Royal Institute of Science, Bombay; Dr. R. N. Ghosh, reader in physics, University of Allahabad; Prof. H. K. Mookerjee, University professor of zoology and head of the Department, University of Calcutta; Prof. V. V. Narlikar, professor of mathematics and head of the Department, Benares Hindu University; Dr. C. G. Pandit, officiating director of the King Institute of Preventive Medicine, Guindy, Madras; Major C. L. Pasricha, professor of pathology and bacteriology, School of Tropical Medicine, Calcutta; Prof. L. Rama Rao, professor of geology, University of Mysore; Dr. M. Sharif, entomologist, Haffkine Institute, Bombay; Dr. K. Venkataraman, director of the University of Bombay Laboratories of Chemical Technology and Textile Chemistry. *Honorary Fellows:* Dr. E. V. Appleton, secretary of the Department of Scientific and Industrial Research of Great Britain; Prof. Charles W. Edmunds, professor of pharmacology and therapeutics, University of Michigan Medical School; Prof. R. A. Fisher, Galton professor of eugenics in University College, London; Prof. Waldemar Lindgren, emeritus professor of geology, Massachusetts Institute of Technology, whose death on November 3 is announced on p. 970.

Royal Society Officers and Council

THE following is a list of those elected as officers and council of the Royal Society at the anniversary meeting held on November 30: *President*, Sir William Bragg; *Treasurer*, Prof. T. R. Merton; *Secretaries*, Prof. A. V. Hill, Prof. A. C. G. Egerton; *Foreign Secretary*, Sir Albert Seward; *Other Members of Council*, Prof. F. C. Bartlett, Prof. P. G. H. Boswell, Prof. F. T. Brooks, Dr. C. G. Darwin, Prof. H. M. Fox, Dr. H. J. Gough, Dr. A. D. Imms, Prof. C. K. Ingold, Prof. G. B. Jeffery, Prof. R. T. Leiper, Prof. H. S. Raper, Sir Owen Richardson, Prof. E. K. Rideal, Dr. F. J. W. Roughton, Prof. W. W. C. Topley, Prof. R. Whiddington.

Announcements

DR. J. B. MENNELL, president of the Section of Physical Medicine of the Royal Society of Medicine, has been awarded a gold key by the American Congress of Physical Therapy for distinguished research on physical therapy during the last year.

DR. ALFRED FROEHLICH, formerly professor of pharmacology in the University of Vienna, has been appointed pharmacologist to the May Institute for Medical Research of the Jewish Hospital, Cincinnati.

THE name of the National Baby Week Council, a body which came into existence during the War of 1914–18, is now changed to "National Baby Welfare Council", this name being more commensurate with the increased scope of work falling to the Council's lot under war conditions. The address of the National Baby Welfare Council is 29 Gordon Square, London, W.C.1.

THE Women's Medical Association of New York offers a Mary Putnam Jacobi fellowship to any woman doctor, American or foreign, to carry on or complete some special problems in medical research. Application should be made by March 1, 1940, to the secretary, Dr. Phebe L. Dubois, 150 East 73rd Street, New York City.

IN his latest quarterly report the Registrar-General states that the number of live births in England and Wales during the thirteen weeks ended June 30 was 222 more than in the corresponding quarter of 1938, and amounted to an annual birth-rate of 16 per thousand of the population. The number of deaths corresponded to an annual rate of 11·7, and the mortality of infants under one year of age to an annual rate of 48, which was 8 below the average of the preceding ten second quarters.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 982. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Analysis of Protein by Means of Deuterium-containing Amino-Acids

As is well known, the analysis of amino-acids giving no colour reactions is very difficult as most of the methods known lead to inevitable losses. This difficulty can, however, be overcome in the following way.

To the hydrolysed protein, of which the leucine content for example is to be determined, is added a known amount of leucine labelled by introduction of deuterium in the (C—H) position. After mixing, some leucine is isolated from the mixture by the usual methods.

The next step is the determination of the deuterium content of the leucine mixture isolated. Where the protein does not contain leucine, the leucine sample recovered should be pure 'heavy' leucine; while from the protein containing normal leucine a mixture of 'heavy' and normal leucine is recovered.

From the deuterium content of the leucine mixture isolated we can calculate the proportion in which the 'heavy' leucine added is diluted by the leucine originating from the protein.

The mixture of amino-acids which is the result of the usual acid hydrolysis consists (with the exception of glycine) of optically active forms, whereas the usual methods for synthesis of amino-acids containing deuterium leads to racemic mixtures. It is necessary therefore, either to perform a resolution of the synthetic product into the *d*- and *l*-forms, or to racemize the amino-acid to be estimated in the hydrolysate. The last path, being by far the least expensive, is followed here.

Deuterium-containing *dl*-leucine was prepared by heating *l*-leucine with 33 per cent sulphuric acid containing, say, 7–10 per cent D_2O in a sealed pyrex tube to 170° for twenty-four hours[1].

After removal of SO_4^{--} and repeated evaporation of the water and re-dissolving in pure water, all deuterium in combination with oxygen and nitrogen is removed, and a portion of deuterium is left which cannot be removed by boiling water. As the leucine is now optically inactive, as was determined in two cases, the stable linked deuterium has obviously entered the molecule during the racemization and is linked to the α-carbon. Under the treatment mentioned, the destruction of leucine did not exceed two per cent. The determination of the deuterium content of combustion water from the leucine is performed by the gradient-tube method of Linderström-Lang[2].

3·0 gm. dry hæmoglobin was hydrolysed and racemized by treatment with 33 per cent sulphuric acid in a sealed ampoule at 170°. The hydrolysate was mixed with 0·392 gm. 'heavy' leucine. Sulphuric acid was removed, the amino-acid mixture dried and powdered. The powder was extracted with dry propionic acid (method of Przylecki and Kasprzyk) which extracts the hexon bases, proline and part of the leucine. Propionic acid was removed and the leucine isolated as copper salt and purified by recrystallization from water. The excess density of the water formed by combustion of the 'heavy' leucine was 518 parts in a million, that of the leucine mixture isolated 225 parts in a million. The amount of 'heavy' plus normal leucine was:

$$0{\cdot}392 \times \frac{518}{225} = 1{\cdot}262 \text{ gm.}$$

The amount of leucine originally present in the protein was

$$1{\cdot}262 - 0{\cdot}392 = 0{\cdot}870 \text{ gm.},$$

which corresponds to 29 per cent of the hæmoglobin.

A second estimation gave 30 per cent. An estimation of the leucine content of gelatine gave 8·5 per cent.

These results should, of course, be regarded as examples only. It should be possible to adopt the method for a series of amino-acids, for example, alanine, valine, isoleucine and aspartic acid, for which to my knowledge no quite reliable estimation methods are known.

HANS H. USSING.

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University of Copenhagen.
Nov. 3.

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A Mucolytic Enzyme in Testis Extracts

WE have recently described a polypeptide, isolated from peptic protein hydrolysates, which is chemotactic to leucocytes and increases the permeability of capillaries[1]. It is probably closely related to Menkin's 'leukotaxine'[2]. As a result of this work we became interested in another permeability-increasing substance, known as the 'spreading factor'[3]. This substance, which is present in large amounts in testis extracts and certain bacterial filtrates, is a protein and is active in dilutions so low as 10^{-8}. It acts by increasing the permeability of the dermal layer of the skin, as demonstrated by the flattening of the wheal and the rapid spread of intradermally injected solutions of dyes, bacterial toxins and particulate matter in suspension.

So far, nothing has been known about the mechanism of the action of the spreading factor. From its properties, it seemed to us likely that it was an enzyme acting on some substrate in the skin, causing

the removal of a barrier to the rapid diffusion of intradermally injected fluids. We have therefore examined extracts of testis, purified by the method of Morgan and McClean[4] for the presence of different hydrolytic enzymes. Our purified testis extracts contained 0·3 per cent of dry material which produced marked spreading in dilutions of 10^{-6}.

Though the testicular extracts were found to contain a proteolytic enzyme of cathepsin character, it seemed improbable that the action of spreading factor was proteolytic, since active preparations of crystalline trypsin (kindly supplied to us by Dr. H. Holter and Prof. Linderstrøm-Lang) did not give any reaction characteristic of spreading factor.

Histological evidence of the existence in the skin of a mucin-like inter-fibrillar substance[5] led us to examine the possibility of the enzymatic action of spreading factor solutions on mucins of different origin. We found that the extracts had a remarkable action on synovial fluid, the viscosity of the latter, measured in an Ostwald viscometer, falling to 1/300 of its original value (being then approximately that of water) when 5 c.c. of the fluid was incubated at 37° for 30 minutes with 0·5 c.c. of testicular extract. This effect was found to be due to the action of an enzyme on a polysaccharide in the synovial fluid, with the liberation of reducing substance (see accompanying table). No liberation of reducing substance was found in a control experiment in which synovial fluid was incubated for 18 hours at 37° with heat inactivated spreading factor solution.

AMOUNTS OF REDUCING SUBSTANCE IN γ, EXPRESSED IN GLUCOSE EQUIVALENTS (METHOD OF MILLER AND VAN SLYKE[6]), IN SAMPLES OF 1 C.C., TAKEN AT DIFFERENT TIME INTERVALS FROM 20 C.C. SYNOVIAL FLUID INCUBATED AT 37° WITH 2 C.C. OF TESTICULAR EXTRACT.

0	hours	34
½	,, ...	32
1	,, ...	65
2	,, ...	105
4	,, ...	158
6	,, ...	192
18	,, ...	274

With Elson and Morgan's[7] test the reducing substance gave the colour reaction for *N*-acetylglucosamin. Quantitative determinations on 10 c.c. synovial fluid incubated for 18 hours at 37° with 1 c.c. of testicular extract demonstrated the appearance of 245 γ/c.c. of *N*-acetylglucosamin. The control experiment set up under identical conditions with heat inactivated testicular extract gave entirely negative results. The split products obtained by dialysis gave a Bial reaction for glucuronic acid. Furthermore, while synovial mucin is precipitated by dilute acetic acid, forming characteristic strings, synovial fluid after incubation for 30 minutes at 37° with 1/10 of its volume of testicular extract yields very much less precipitate with acetic acid, while after 60 minutes the solution remains clear. Since the enzyme brings about the disappearance of the most characteristic property of synovial mucin, it can be called a mucinase.

Testicular mucinase was found to act also on a polysaccharide present in vitreous humor, the liberation of reducing substance (expressed in glucose equivalents) from 15 c.c. of dialysed vitreous humor incubated for 18 hours with 1·5 c.c. of testicular extract being 71·5 γ/c.c.

Further work is in progress on the properties of the enzyme and its substrates, especially on the relationship of the latter to the polysaccharides from umbilical cord, vitreous humor and synovial fluid, isolated by Meyer and Palmer[8] and Meyer, Smyth and Dawson[8].

Since the properties of the mucinase are identical with those of spreading factor, and since the occurrence of spreading factor in bacterial filtrates has so far been found to go parallel with their mucinase content, we think it probable that mucinase and spreading factor are identical. We are undertaking further experiments in the hope of being able to prove this point conclusively.

E. CHAIN.
E. S. DUTHIE.

Sir William Dunn School of Pathology,
Oxford.
Nov. 4.

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Vitamin A Content of the Livers of a Hundred Healthy Dogs

ALTHOUGH under natural conditions largely carnivorous in its dietary requirements, the domesticated dog will accept with apparent relish a diet more fitted for an omnivorous or even vegetarian animal. Flesh, milk, cereals and vegetables make up the bulk of the ration, the proportions of these varying according to the fancy or perhaps the financial circumstances of the owner. Thus the amount of vitamin A available to the dog will vary greatly.

Holmes *et al.*[1] found that under the conditions obtaining on a fur farm from which they obtained their material, the vitamin A content of the liver of the mink and the raccoon was less than that of wild specimens of these species. However, they also showed that two wild opossums, captured and fed in captivity for six months on a diet of high vitamin A value, were able to store the vitamin to a much higher extent than three wild opossums which had been captured at the same time as the above two, and were destroyed.

Bradfield and Smith[2] found considerable variations in the vitamin A content of the liver in dogs which were being fed, under controlled conditions, on equal amounts of vitamin A. Chevalier and Choron[3] showed that in 100 guinea pigs fed on the same diet, variations occurred in the vitamin A content of the liver of from 5–10 blue units per gram to 300 blue units per gram. Simmonet *et al.*[4] found considerable variations in the vitamin A reserve of the liver of six clinically normal dogs.

That the liver of newborn puppies contains little vitamin A reserve was shown by Busson and Simmonet[5], who found their liver to be inactive even when that of the dam contained an ample store.

The dogs used for the present work were unwanted dogs, which had been destroyed by coal gas poisoning. They were not bled. The histories of these animals were not obtained. They were probably all city dogs, and were presumed to be healthy.

Technique. A piece of liver was removed within a few hours after death, placed in cold storage overnight, and on the following day 5 gm. was weighed out in duplicate, minced with scissors, 15 c.c. of 5 per cent caustic potash added, and kept in cold store if not being dealt with immediately.

The vitamin was extracted according to the method of Davies[6]. The unsaponifiable portion was dissolved in 10 c.c. of chloroform, and the blue units determined by the use of a Lovibond tintometer. In the large majority of cases, an amount of the chloroform solution was taken such as would give a reading of blue units between 3 and 6, but readings slightly beyond this range were used as the basis for calculating the results in a minority of cases.

Results. Great variation in the liver reserve of dogs has been found to occur. Whether this is associated with the amount of vitamin available in the food, or with the ability to absorb and store it in the liver, is not here indicated. The average of these reserves was found to be 678 B.U./gm., but, as pointed out by Moore[7], the average figure may be misleading owing to the wide variations, and the medial figure is a more reliable one to take as an indication of a standard. The medial figure in our series (taking an average of the six central figures) is 153·5 B.U./gm.

The exact age of these dogs was not known. Six which were only a few months old gave values 9, 10, 36, 47, 62 and 70 respectively. At the other extreme of life, greater variation in the vitamin store appeared to occur. In seven old dogs the values were 26, 36, 103, 171, 206, 340, 1125.

In twenty-three lean or poor-conditioned dogs, the average vitamin A content was 415·8 B.U./gm., with a range of from 11 to 2800, and in three very fat dogs the figures were 8, 171, 447. From these limited data there does not appear to be an association between the vitamin A reserve and the body condition in the dog.

Moore[7] showed that in the rat a condition of extreme emaciation did not necessarily lead to a diminution of the vitamin A reserves of the liver, and one of us (R. G. L.) found large reserves in the livers of hens and geese that had been starved to death by their owner.

R. G. LINTON.
A. BROWNLEE.

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Monogenic Broods in *Armadillidium vulgare* Latr.

VANDEL[1] has found that in the woodlouse, *Trichoniscus provisorius*, there occur both amphogenic broods (broods containing approximately equal numbers of both sexes) and monogenic broods (broods consisting of one sex only or very nearly so). He accounts for the occurrence of arrhenogenic broods (broods consisting of males only) and thelygenic broods (broods containing only females) by suggesting that in woodlice the female is the heterozygous sex (chromosomes *XY*) and that the segregation of the sex chromosomes in monogenic females is controlled by the cytoplasm. Thus in arrhenogenic females every egg receives an *X* chromosome and the *Y* chromosome always passes into the first polar body. Such a female, therefore, produces broods containing only males.

One of the main arguments for accounting for monogenic broods in this way is that the male has no effect on the type of brood produced. Vandel's evidence for the male having no effect on the type of brood produced is that in several cases all the females of any one brood mated with either 'ordinary' males (from amphogenic broods) or with 'exclusive' males (from arrhenogenic broods) produced either all arrhenogenic or all thelygenic broods. Sister females thus resembled each other in producing the same type of monogenic brood no matter what type of male they were mated with.

Amphogenic and monogenic broods have also been found in the woodlouse *Armadillidium vulgare* Latr. by Howard[2] and Vandel[3]. By mating males of *Armadillidium* to two or more females I have also been able to show that the male has probably no effect on the type of brood produced. The same male mated to two different females may produce both arrhenogenic and thelygenic broods or both amphogenic and monogenic broods. The data are given in the table.

Parents of brood		Constitution of brood	
Male	Female	Males	Females
B	*A*	1	36
B	*AB*	22	9
AM	*AB*	34	8
AM	*AJ*	6	50
AL	*CB*	1	37
AL	*CC*	0	25
AL	*CD*	64	0
AN	*BK*	45	0
AN	*U*	0	56
SB	*DA*	0	30
SB	*EA*	46	47

It seems, therefore, very probable that it is the female which determines the type of brood produced. It has also been possible by using different genetical types to show that neither arrhenogenic nor thelygenic broods are due to parthenogenesis.

The above data also have another interest. The three females, *CB*, *CC*, and *CD*, are all from the same brood. One brood may, therefore, contain both arrhenogenic and thelygenic daughters. Also female *BK*, parent of an arrhenogenic brood, was a daughter of a thelygenic female (female *A* in the table). Such facts will have to be considered in suggesting schemes for the inheritance of arrhenogeny and thelygeny. It seems possible that while the male has no effect on the sex ratio in a brood, he does have an effect in determining the types of females produced.

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Nov. 15.

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Hypertensin: the Substance Causing Renal Hypertension

AN increase in blood pressure is produced by compression of the renal artery[1] or by injection of the venous blood of the kidneys[2]. The filtrate obtained after adding 3 vol. of acetone to the serum of this blood contains a pressor substance which is insoluble in ether and amyl alcohol, soluble in glacial acetic acid and is destroyed only after three hours boiling in normal hydrochloric acid. The same substance is formed on incubating for fifteen minutes at 37° the kidney protein renin[3] with blood serum or its pseudo-globulin fraction. This substance, which we name hypertensin, is different from adrenalin, tyramin, pitressin and urohypertensin. Renin appears to be a proteolitic enzyme of the papain type, which liberates hypertensin from a blood protein belonging to the pseudo-globulin fraction.

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Relation of the Nucleolus to Secondary Constrictions

IN discussing the relation of the nucleolus with the *SAT* chromosomes, investigators do not appear to notice that the 'constriction' is probably *due* to the nucleolus, rather than an active producer of that body[1]. I imagine the chromosome in a close spiral. The nucleolus develops at a definite point in the chromosome and pushes the spirals apart until that part of the chromosome becomes a straight thread and apparently much thinner than the remainder of the chromosome. When the *SAT* chromosome in Navashin's Crepis[2] was not able to develop a nucleolus because the nucleolar material had already been removed by another chromosome, it had no satellite either. The darkly staining portions just below the thin stalk in McClintock's Zea chromosomes[3] could also be explained by the spirals beyond the nucleolus being pushed more closely together.

That a nucleolus can interfere mechanically with a chromosome is seen clearly in the salivary glands of Chironomus, the chromosomes in which often have enormous nucleoli. Here the usually fused homologues are seen to be separated in the region of the fused nucleoli and the chromatin of each homologue also is often much dispersed[4,5].

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IT is true, as Miss Melland states, that the nucleolus as it grows can interfere mechanically with the structure of a chromosome. It can, for example, stretch the filament which connects the satellite with the body of the chromosome. This is done by despiralizing the filament. Nevertheless the filament appears to be a spiral of a lower order than the spiral chromonemata which make up the body of the chromosome. It is already present in anaphase chromosomes before the nucleolus begins to appear. The same is true of secondary constrictions which give rise to nucleoli. These features of chromosome structure are for this and other reasons not produced by the growing nucleolus merely pushing the gyres of the spiral chromonema apart.

It is not possible to discuss the subject more in detail here. A series of papers are now in the press dealing with nucleolar production in a number of plant genera. The conditions vary in some respects from genus to genus, but there is evidence of various kinds that the nucleolar secondary constrictions as well as the nucleolar body in a *SAT* chromosome are definite loci of the chromosome, and that the secondary constrictions are already determined before the nucleolus begins to appear in telophase.

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Calcium in Ciliary and Muscular Movement

IT is interesting to note that the *unbalance* obtained by reducing the calcium content of physiological solutions can to some extent be offset by the addition of small quantities of lipoids to the solution. Thus frog heart rendered hypodynamic, or even arrested, by Ringer solution less varying amounts of calcium chloride, can be made to beat normally again by adding small quantities of sodium oleate, of sodium palmitate, of impure lecithin, or of ox blood thrombin to the Ringer, the *p*H being maintained unaltered. The effect was not observed with very pure lecithin or very pure kephalin, but a similar effect was obtained with lyso-lecithin, which first reduces the beat and also contracts the heart. Similarly, Clark and others[1] have shown that frog heart rendered hypodynamic by prolonged beating in Ringer solution shows increased activity when given extra calcium, sodium oleate, impure but not pure lecithin, impure but not pure kephalin, or serum. Ox blood thrombin, serum, and all but the purest samples of phospholipins contain traces of soaps which may well account for the activity of these substances in offsetting calcium deficiency. Mytilus cilia will beat for some time in artificial sea water at *p*H 6·5, but are quickly arrested if they are put in a similar medium at the same *p*H without calcium (removed as chloride)[2]. The ciliary beat is restored in such a calcium-free solution at the same *p*H if traces of one of the following substances are added: sodium dodecyl sulphate (the magnesium present rendered the oleate and palmitate of sodium insoluble and therefore ineffective), hexadecyl-trimethyl-ammonium bromide, lyso-lecithin, impure lecithin, or ox blood thrombin. Triolein, sodium butyrate and sodium glycerophosphate showed no restorative effect. In considering these facts, it should be noted that calcium is found to be more active under lipoid than under protein monolayers.

Heilbrunn[3] maintains that at least in some types

of cells stimulation causes a liquefaction of the gellike cell cortex with release of calcium, some of which is transferred to the cell interior, which ultimately gelates or clots by a process similar to the clotting of blood. Fat-solvent anæsthetics favour release of calcium from the cortical plasmagel but prevent internal clotting. Plasmagel is formed by a clotting-like reaction from plasmasol, and Heilbrunn calls this process the 'surface precipitation reaction'. Mitosis and fertilization are processes fundamentally akin to excitation, according to Heilbrunn, who says that they involve liquefaction of the plasmagel and a subsequent clotting of the plasmasol which only becomes fluid again at the first appearance of the spindle. Needles dipped in serum are more active in producing parthenogenesis than those undipped[3]. Thrombin accelerates mitosis in tissue culture[2], and heparin inhibits it[3]. Heparin at 1 : 100,000 also inhibits the formation of fertilization membranes in Echinus eggs[4]. The similarity of the effects of ion-balance on muscular, ciliary, and amœboid movement are well known[5]; calcium is released during muscular activity[3] and at the tip of an advancing amœboid pseudopod[6]; and most modern authors agree that gelation and solation are primarily responsible for amœboid movement.

It is submitted that the observations recorded above are essentially in agreement with the hypothesis of Heilbrunn that has just been discussed, and suggest that it can be extended to ciliary movement. Further studies of ion balance in the cases of living tissues and of inanimate lipo-protein systems are necessary if these suggestions are to be followed up.

Heilbrunn[3] also points out that many parthenogenetic agents cytolyse Echinus eggs by destroying or liquefying the plasmogel cortex of the egg, and also gelate the cell interior when used at higher concentrations than those required for normal parthenogenesis. Thus an agent that stimulates at low concentrations cytolyses at higher concentrations. A parallel to this is the action of stronger solutions of sodium dodecyl sulphate, of hexadecyl-trimethyl-ammonium bromide, or of lysolecithin on Mytilus cilia, since the arrested cilia first start to beat and continue to beat in calcium-free solutions for some time after cytolysis has all but destroyed the form of the individual cilia.

The cytolysis by sodium dodecyl sulphate and by hexadecyl-trimethyl-ammonium bromide suggests that the ciliary surface is largely lipoid in nature[7]. It has also been found that protein monolayer adsorbants or dispersants, such as substituted 4-4'-dihydroxy diphenyl or stilbene compounds which affect protein films at 1 : 2,000,000[7] and tannic acids, do not affect the beat of Mytilus cilia at low concentrations. The cilia are relatively insensitive to cytolysis by saponin or by cobra venom; the former penetrates films of certain sterols[8] and the latter releases lyso-lecithin from lecithin by lecithinase action, and lyso-lecithin itself has been found to cytolyse the cilia. Similarly Paramecia are affected by both lipoid and protein film adsorbants[7].

These facts suggest that all cells which show movement have some lipoid constituents in their surfaces, that the movement normally requires calcium, and that calcium lack can be offset by external supplies of certain lipoids. If Heilbrunn's suggestions are correct, cytolysis and stimulation liquefy the cell membrane and liberate calcium, which coagulates the cell interior by a process related to the clotting of blood. A study of ion balance in lipo-protein systems and of the role of lipoids in muscular action should help elucidate the problem.

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Spectrum of the Torch Discharge

THE so-called 'torch discharge'[1] (*Flammenbogen*[2]) in air, which can be created at a single electrode in the ultra high-frequency undamped oscillation circuit ($10^7 \sim 10^8$ Hz.), has been the subject of some investigations, but the main interest has been directed towards its chemical aspect; no attempts seem to have been made to study its spectrum. With the view of gaining an insight into the mechanism of the discharge, we have carried out an extensive examination of the spectrum.

In the flame part of the discharge, the spectrum consists chiefly of the O_2 (Runge), NO(γ) and OH bands, while in the neighbourhood of the electrode the N_2 and N_2^+ bands, as well as some easily excitable

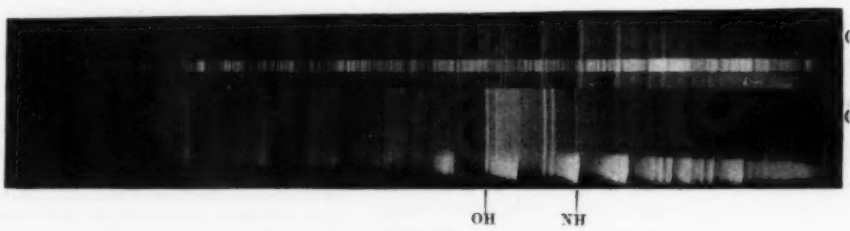

Fig. 1.

lines of the electrode material, come out with strong intensity. From all portions of the flame a continuous band extending from about 6000 A. up to the red end is emitted; its origin is unknown, but one may be able to infer fresh interpretation as to the mechanism of the chemical reactions going on in the discharge. With increasing current density NH (*Q* branch of the 3360 band) also makes its appearance, and the metallic lines of low excitation potentials

extend into the flame (Fig. 1*a*). The spectrogram of the pure oxygen band, which is obtained in the torch flame in oxygen at atmospheric pressure, is reproduced in Fig. 1*b*.

If the torch is struck in a closed vessel containing air, the absorption bands due to NO_2 appear in the visible and near ultra-violet region, and the NO (0,0), (1,0) bands become 'self-reversed'.

It is to be noted that the torch spectrum is found to be essentially the same as that of the high-tension D.C. arc[3] (*stromstarke Glimmentladung*[4]), so that, so far as the nature of the spectrum is concerned, no features distinctively characteristic of the ultra high-frequency oscillations can be detected.

A complete analysis of the Runge band will be published elsewhere.

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Comparing Resistances of Four-Terminal Resistors

Two communications regarding the comparison of four-terminal resistances, the first by Mr. Arvon Glynne and a further one by Prof. John Dowling, have recently appeared[1] in NATURE.

I would like to point out that the method described by Mr. Glynne is already well known and will be found in Law's "Electrical Measurements", published by the McGraw-Hill Book Company, first edition, 1917, on p. 190, where the identical formula is given.

There is considerable practical difficulty in applying this method, first owing to the presence of thermo-electric effects at the terminals, which are usually different for each position of the galvanometer, and secondly, owing to the dependence on the constancy of the connexion between the two resistances under test. In order to obtain accurate comparisons, it would be necessary to compensate for the thermo-electric effects and to make the change-over from position one to position two with great rapidity. This cannot easily be done when the resistance *B* has to be altered for the two balances.

To overcome these difficulties, I modified the method[2], and the complete instrument was exhibited at the Physical Society in January 1938. This method has been in continual use for precision comparisons since then, with the addition of a circuit for compensation for thermal E.M.F.'s at the terminals. The compensating circuit avoids the use of two zeros on the galvanometer—one for each balance.

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Points from Foregoing Letters

HANS H. USSING describes a method of analysing protein by means of amino-acids containing deuterium. The author claims that the method overcomes the difficulty met with in most types of amino-acid analysis, which usually lead to inevitable losses and are therefore only approximate. He also suggests that his method can be used for such an amino-acid series as alanine, valine, isoleucine and aspartic acid, for which no very reliable methods of estimation are at present known.

E. Chain and E. S. Duthie report on an enzyme occurring in purified 'spreading factor' extracts from testis hydrolysing rapidly a polysaccharide in synovial mucin with liberation of reducing sugars. A large and rapid decrease in viscosity occurs during the early stages of hydrolysis and the mucin becomes non-precipitable by dilute acetic acid. The possible identity of this enzyme with 'spreading factor' is discussed.

The vitamin A content of the liver of a hundred presumably healthy dogs was found by R. G. Linton and A. Brownlee to average 678 'blue units' per gram of liver tissue, with a medial figure of 153·5 and a range of 4·5 to 19,625.

In *Armadillidium vulgare* Latr. there are found broods consisting of one sex only. H. W. Howard finds that the male parent probably has no effect in determining the type of brood produced. This supports Vandel's theory that the segregation of sex chromosomes is determined by the cytoplasm of the female.

J. M. Muñoz, E. Braun-Menéndez, J. C. Fasciolo and L. F. Leloir report that renal hypertension is caused by the formation of 'hypertensin', a substance which is different from other known pressor substances. It has been found in venous blood of ischæmic kidneys and can be prepared *in vitro* by the interaction of renin and pseudo-globulins of normal serum.

A. M. Melland stresses the probability of the nucleolus *producing* the secondary constriction in a chromosome, rather than the nucleolus *arising* from that constriction. R. Ruggles Gates, commenting on this letter, points out that while the growing nucleolus can separate the gyres of a chromosome spiral, yet the nucleolus takes its origin at a predetermined locus of the chromosome whether the latter has a satellite or a secondary constriction.

The unbalance obtained by reducing the calcium content of physiological solutions can to some extent be offset by the addition of small quantities of lipoids to the solution in the case of the beating of frog heart and of Mytilus cilia. According to G. S. Carter *et al.*, the use of adsorbants and dispersants of protein film and of lipoid film suggests that ciliary and muscular cell membranes have some lipoid constituents on their outer sides. It seems that the role of lipoids in questions both of ion balance and of muscular activity needs investigation. The data are not inconsistent with the hypotheses of Heilbrunn concerning mitosis and excitability.

D. C. Gall gives an earlier reference and comments upon a method of comparing four-terminal resistances, recently described. Attention is also directed to an improved method.

RESEARCH ITEMS

Tongan Colour-Vision

DATA of colour-vision among Polynesian Tongans were collected by Ernest and Pearl Beaglehole in the course of a field trip to Tonga, employing the Ishihara test (seventh edition). Results are recorded in *Man* of November 1939. 135 Tongans were examined (male, 67; female, 68). Five males appeared to be red-green blind; but no case of female red-green blindness was detected. No cases of blue-yellow blindness, or of complete colour-blindness, were detected in either sex. A comparison of the percentage of red-green blindness in Tongan males (7·46) with comparable results in Whites (8·03), American Negroes (3·7), American Indians (1·7), taken in conjunction with the weight of evidence from all test results available, suggests a possible racial difference in the incidence in males of red-green colour-blindness. Of the five Tongan males with defective colour vision, two were completely green-blind. The proportion of green-blindness to red-blindness among Whites, Negroes, and American Indians as reported is also in the approximate ratio of three to one. Another peculiarity in Tongan subjects is the response of certain of them in the test to plates which can scarcely be read by normal subjects. These Tongans (10 male, 13 female) were otherwise normal. In regard to general colour discrimination a number of colour-names were collected—cream-white, skin-white, yellow or gold, yellow, red, black. There is no specific colour-name for blue, nor possibly for green either. Many descriptive colour-names are in use, as for example, colour-sea = blue; obscure, indistinct = brown; *kupesi*, stencil for marking bark cloth = dark brown; *loufusi*, banana leaf = deep green. Degree of saturation is expressed by such qualifying words as *mama*, light, *fakapo' opouli*, dark. The absence of certain terms, for example, for blue, does not imply a poor colour discrimination, but is due to a difficulty in finding words to describe them, and arises from a cultural origin.

Pawnee Archæology

IN planning the work of the Nebraska Archæological Survey established in 1929, Dr. W. D. Strong suggested a line of attack which would establish a time sequence from known historic to unknown prehistoric. The Pawnee for various reasons offered the most suitable material for the first systematic attempt at isolating a historic archæological complex in Nebraska. During the nineteenth century, with two or three apparent exceptions, Pawnee villages centred about the confluence of the Loup with the Platte River, standing on terraces or second bottoms well out of reach of the floods. Beyond the tree-fringed watercourses are the dry, formerly grass-covered uplands suitable only for hunting; but it was the fertile river-bottoms, with abundance of wood, water, arable ground and shelter, which determined the location of their villages. The extreme limits of Pawnee settlement were on a 120-mile stretch of river valley, along which they shifted continually, but leaving it only for seasonal hunting. The sites show a somewhat decadent aboriginal culture, yielding also iron, copper, brass and glassware. Within this area but with more limited distribution are found sites with a more abundant, superior culture and smaller quantities of white contact material. Generally the sites are large (50–100 acres or more), compact and selected with an eye to defence, some having earth-walls and ditches for protection. Excavation on these proto-historic sites has produced evidence which has been assigned to a 'Lower Loup focus', while another culture, possibly contemporary, has been revealed at Leary in south-west Nebraska, to which the name Oneota culture has been given. The relations of Lower Loup, Oneota and historic Pawnee have been discussed by Waldo R. Wedel (*Smithsonian Misc. Collect.*, 97, 7; 1938) in the light of analysis of material culture and examination of the documentary evidence of early travellers. By some it is maintained that Lower Loup is more closely related to Oneota than to historic Pawnee, but analysis of cultural traits points to the closer relation of Lower Loup and historic Pawnee, the probability that the former is ancestral to the latter, after a period of decadence, being rendered stronger by the absence of any evidence that settlements, of the size and importance indicated by the sites, were made here by a sedentary, horticultural people other than the Pawnee since the arrival of Europeans.

The House-Sparrow in Canada

THE house-sparrow (*Passer domesticus*) has been long established in Canada, and a recent investigation by Richard Lee Weaver suggests that it reached its peak of abundance several decades ago, and since then has in some parts declined in numbers (*Canadian Field-Nat.*, 53, 95; October 1939). In general, the northern limit appears to be determined by the limit of systematic cultivation, although occasional colonies persist beyond that boundary in the neighbourhood of settlements. Occasionally, too, specially favourable conditions induce a northward movement, such as established the birds at Churchill, on Hudson Bay, but in such cases the severe winters cause many deaths, and at Churchill the danger of extermination is circumvented only because the sparrows inhabit in winter the railroad roundhouse, where they get shelter and food from man. The change in locomotion from the horse-traffic of early days to the motor-car has made extraordinary differences in the sparrow population in towns, for the hordes of sparrows which once, according to a note by the Ornithological Editor, made sidewalks unusable and in another way interfered with church services, have disappeared with the disappearance of horses and the droppings which formed a main food supply in winter.

Reproduction of the Spotted Hyæna

SOME unestablished peculiarity about the sexual anatomy and physiology of the spotted hyæna (*Crocuta crocuta*) led writers of antiquity to assert that it was hermaphrodite. Scientific study of the subject has been meagre, but this statement no longer holds good in view of the investigation of L. Harrison Matthews, who travelled to East Africa to study the animal and records the results of the examination of 103 individuals (*Phil. Trans. Roy. Soc. Lond.*, Ser. B, No. 565, 230, July 1939). This random sample had a sex ratio of 61·1 per cent of males. The anatomical

puzzle arose from the peculiarity of the female genitalia, which possess a clitoris, perforated by the urinogenital canal, so similar to the penis of the male that male and non-parous females are indistinguishable externally. There is no annual breeding season for the female in Tanganyika Territory, all stages of sexual activity being found at the same time. In the absence of fertilization, a dioestrous cycle of about a fortnight occurs. Following fertilization, gestation lasts about 110 days, the lactation period extends over six months, and the complete sexual cycle lasts nearly a year. The author suggests that the peculiar male facies of the female may be produced by an excess of androgenic substances, accompanied probably by a deficiency of œstrogenic ones, derived from the ovary. The limit of life of the spotted hyæna appears to be about ten years.

Choice of Water by the Honey Bee

C. G. BUTLER of the Rothamsted Experimental Station has described the habit of bees collecting water from many undesirable sources that are often choked with decaying organic matter (*Bee World*, November 1939). It seemed, therefore, of interest and importance to discover what attracts bees to such sources of water. In his experiments most of the salts essential to animal life were tested in various concentrations against distilled water. Only in the case of very dilute sodium chloride and ammonium chloride were the bees attracted more than to distilled water. The optimum concentration was between 0·15 per cent and 0·07 per cent; with progressively stronger solutions the bees showed increasing preference for distilled water. Rain water, from a leaf-choked gutter, was next taken and tested against distilled water and the salt solutions. More than 90 per cent of the bees chose the rain water. Further experiments showed that bees were being attracted to this source of water by smell alone, and that their liking for very dilute salt solutions has little or nothing to do with their finding a source of drinking water. It is suggested that it is best to fill apiary drinking fountains with rain water to which is added sufficient sodium chloride to make it into a 0·1 per cent solution.

Water Movement and Radial Growth in Trees

W. R. C. HANDLEY has recently published some observations on the effect of prolonged chilling on these processes (*Ann. Bot.*, N.S., 3, No. 12, 803; 1939). By subjecting woody shoots of young saplings of ash and sycamore to continuous cooling to 2° C. during the season of growth, radial growth was almost completely inhibited, though not extension growth (which was, however, later in starting and proceeded more slowly). When cooling was extended to 0° C., leaf-wilt occurred owing to still further reduction in water conduction. Turgidity recovered on raising the temperature again to 2° C.

Wound Hormones in Plants

J. English, J. Bonner and A. J. Haagen-Smit (*Proc. Nat. Acad. Sci.*, 25, 323–329; 1939) have isolated a crystalline substance of composition $C_{13}H_{20}O_4$ which is capable of inducing renewed cell division and cell extension in parenchymatous cells. This substance was isolated from fresh bean pods. The activity of the substance is about a hundred times that of the original material, but this varies considerably. This variation is probably due to the fluctuation in the amount of co-factors in the test material. Such co-factors have been identified during the chemical preparation, while sucrose and glutamic acid were found to increase greatly the activity of the di-basic acid $C_{13}H_{20}O_4$.

Aphid Vectors of Sugar-cane Mosaic

THE aphid *Aphis maidis* has been recognized for a considerable time as a transmitting agent for the sugar-cane mosaic virus. H. D. Tate and S. R. Vandenberg have shown, however (*J. Agric. Res.*, 59, No. 1, 73–80, July 1939), that two other aphids, *Carolinaia cyperi* and *Hysteroneura setariæ*, which may occur on the crop in Porto Rico, are also vectors of this particular disease. These insects inhabit the weeds *Cyperus rotundifolia* and *Eleusine indica* (goosegrass), which are common in sugar-cane plantations, and doubtless play a considerable part in the spread of mosaic under field conditions. A fourth kind of aphid, *Sipha flava*, was unable to transmit the virus. The results supply yet another instance of the close relation between a virus and its insect vector.

Indirect Damage by Narcissus Leaf Diseases

RESULTS of several recent investigations into the damage caused by fungi the general attack of which upon their host plants appears to be slight have often revealed more extensive indirect damage. Such a state of affairs has now been demonstrated by P. H. Gregory for several leaf diseases of the narcissus ("R.H.S. Daffodil Year Book", pp. 49–53, 1939). Leaf scorch, caused by the fungus *Stagonospora Curtisii*, white mould, which results from the parasite *Ramularia vallisumbrosæ*, grey mould (*Botrytis narcissicola*) and fire (*Sclerotinia polyblastis*) are widespread in the commercial bulb districts of the south-west of England; but it is not certain whether they invariably cause substantial loss of the crop. Dr. Gregory has shown that their indirect effects, at any rate, are quite substantial. The leaf spotting fungi spread upon the foliage after the time of flowering, and often curtail photosynthesis, so that subsequent flower crops are affected. Spraying the foliage with Bordeaux mixture resulted in increased bulb weight, enhanced flower quality, and, most important of all, considerably greater flower crop. Gains in flower production as high as 70 per cent over unsprayed foliage have, in fact, been recorded. Further measures of plant hygiene, such as the removal of infected foliage and flowers, are recommended, whilst routine lifting and replanting of the bulbs usually eradicates the diseases if fresh foliar infection does not occur.

Structure of Complex Fluorides

AMONG compounds of the type R_2MX_6 (R = K, NH_4; M = Si, Ge, Sn, Ti, Zr, Mn) only the fluosilicates have been prepared in crystalline modifications possessing the fluorite-like arrangement of R^+ and MF_6^{--} ions known as the ammonium chloroplatinate type. J. L. Hoard and W. B. Vincent (*J. Amer. Chem. Soc.*, 61, 2849; 1939) have examined by the X-rays the atomic arrangement in crystals of ammonium and potassium fluogermanates. The crystals possess one-molecule hexagonal units of structure, and the crystal structure is an aggregate of univalent cations (K^+, NH_4^+) and nearly regular octahedral anions (GeF_6^{-2}) with Ge — F = 1·77 A. Each cation is surrounded by nine nearly equidistant

fluorine atoms and three others at somewhat greater distances. The structure is of the same general type as that of the hexagonal modification of ammonium fluosilicate; it is found only in the case of complex fluorides, for which at ordinary temperature it is usually preferred to the cubic ammonium chloroplatinate structural type.

Structure of Water in Ionic Solutions

THE effect of the presence of ions on the structure of water molecules has long been the subject of investigation and discussion. In a recent article (*J. Chem. Phys.*, **10**, 869; 1939), G. W. Stewart reports data on the variation of the X-ray diffraction pattern of water with concentration of dissolved electrolytes (NH_4Cl, LiCl, NaCl, KCl, and $MgCl_2$), and draws the following direct conclusions from a consideration of the displacements of the major and minor diffraction peaks: (i) the increase in concentration of ions causes the amount of 4-co-ordinated water structure to decrease and produces a more closely-packed arrangement, with a consequent increase in density; (ii) the effect of the ion on the water structure is not confined to that shell immediately adjacent to the ion; and (iii) the alteration in structure is apparently similar to that produced by increasing the temperature of water. Further, from measurements on the alteration of the minor diffraction peak by fifteen strong electrolytes, selected because of their wide variation in type and in apparent molal ionic volume, he shows that the liquid structure of water varies with ionic concentration at a rate comparable with the rate of variation of the apparent molal ionic volume. It seems, in fact, that the alteration in liquid structure has an effect on the apparent molal ionic volume much more important than has the electrostatic effect based on the Debye-Hückel theory. On the basis of these interesting data the author draws a picture of the solvent and its alteration in density by the ion solute which agrees with the conception of Bernal and Fowler (*ibid.*, **1**, 515; 1933). Water at temperatures just above the melting point has a co-ordination number greater than that in ice, and the packing is correspondingly closer in the liquid. This difference explains the latent heat of fusion, and the increase in density of water on melting. The structure of liquid water is not rigid, as in a crystal, and the relation of any molecule to its neighbours is constantly changing. Co-ordination bonds are broken and re-made. The water is homogeneous only if a representative group of molecules is considered. The effect of ions is not to contract the structure but to increase the co-ordination number, and thus change the closeness of packing.

Stellar Structure and Stellar Energy

AN interesting paper with the above title has been published by W. H. McCrea (*Occas. Notes, Roy. Astro. Soc.*, No. 6; October 1939). He gives a short summary of the present position on attempts to utilize known physical laws to explain the mechanism of energy-generation responsible for the maintenance of stellar luminosity. The problem is to discover a mechanism of energy-generation that will be consistent with the physical conditions prevailing in the star. The problem of stellar structure can be stated in its generality as follows: given in some region of space a quantity of matter of known chemical composition and given its initial physical state, what will be its subsequent history? The problem would be soluble in principle if the physicist knew how the material components can interact with each other and with radiation, including the various ways in which the interaction could generate energy. The following points seem to be fairly well established. In the brighter stars of the main sequence, the energy-generation is provided by the formation of helium from hydrogen, and these stars have a large hydrogen content, their central temperatures being about 20 million degrees. While there is no evidence that the synthesis of heavier nuclei in stars occurs, it is certain that some of these nuclei have an essential role as catalysts in the synthesis of helium. Stars of the main sequence, the masses of which are not too great, ultimately contract and become white dwarfs. The giant stars present a difficulty if, as is predicted by the theory of stellar structure, they have relatively low central densities and temperatures. Gamow's suggestion of processes in which there is resonance between an energy level of a nucleus and the energy of a penetrating particle has not been substantiated, and it seems certain that there is an essential distinction between the structure or mode of energy-generation or both in the giants and main-sequence stars. Among the problems awaiting solution are the ultimate fate of massive stars, the mechanism of energy-production in giants, and the origin of heavier nuclei in stellar material.

Sunspots and Magnetic Disturbances

H. G. ARCHENHOLD has recently published a paper on the influence of the variability of the mean latitude of sunspots on the recurrence tendency of magnetic disturbances (*Mon. Not. Roy. Astro. Soc.*, **99**, 9; October 1939). As is well known, the rotation of the sun varies with the latitude; also, the mean latitude of sunspots changes systematically during a sunspot cycle. In the first years, that is, after a sunspot minimum, the mean equator distance of the spots is about 20°, and at the end a little more than 5°. The synodic period of rotation corresponding to these latitudes is 27·5 and 26·9 days, respectively, and if terrestrial magnetic phenomena are connected with the areas of sunspots, there should be a sensible difference between the recurrence intervals in years of low and high sunspot latitudes. Chree and Stagg used the magnetic character figures of the years 1906–1925 and could not detect any effect in the case of terrestrial magnetism, but Archenhold has utilized data going back to 1847 and arrives at a different conclusion. As the data are not uniform, he found it necessary to employ different methods of analysis for different periods, and very full details are given of the procedure adopted. For all the groups dealt with he finds a recurrence interval of 27·02 days for the years before sunspot minima and of 27·52 days after the minima. The mean error of the first value is ±0·13 day, and that of the second is ±0·05 day. The difference of 0·5 day between the recurrence intervals in years before and after sunspot minima is thus 3·6 times the mean error, ±0·14 day. From the beginning of the cycle to the end, the recurrence interval shortens continually, and this is what would be expected because of the decrease in the mean equator distance of the sunspots. When sunspot zones occur near the equator and also in higher latitudes, the shorter recurrence interval of the equator belt prevails, because of the greater effectiveness of disturbed areas near to the equator on the earth's magnetism.

MEDAL AWARDS OF THE ROYAL SOCIETY*

COPLEY MEDAL

THE COPLEY MEDAL has been awarded to Prof. THOMAS HUNT MORGAN.

The establishment of definite laws of heredity, and the discovery of the mechanism, the gene, by which hereditary qualities are carried on from generation to generation, has revolutionized our outlook on the function of the nucleus of the cell and of the chromosomes it contains; it has enabled us to understand the significance of the maturation of the germ cells and of fertilization as they occur in higher animals and plants, and thus led to a very rapid development of nuclear cytology. The theory of the gene has given us a new outlook on the determination of the development of an animal or plant. But nowhere has genetics produced greater changes than in our attitude to evolution. The observations that mutations arise *de novo* at a definite rate, that the number of different mutations occurring in a single species may be very large and that the mutations in allied species are essentially identical, have shown us for the first time the materials which are available as a basis for evolutionary change. The quantitative nature of genetics has made it possible to examine the effects which result after many generations from the establishment of a community by a few individuals of different hereditary composition, and to estimate the effect of a definite advantage attaching to one particular quality on the ultimate composition of a population. It has thus put the theory of natural selection on a sound theoretical basis. Furthermore, it has enabled us to observe indirectly the effects of natural selection in wild populations, and to plan experiments to determine its effects.

The practical applications of genetics are as important as its influence on theory. The whole of the breeding of many cultivated plants including maize is now firmly based, and the process of improvement immensely hastened by cytological examination. Genetics is already influencing animal breeding, and in its modern developments is throwing much light on the possibility of controlling hereditary diseases in man.

In the development of genetics, the work of the Morgan school has been paramount. It is to Morgan that we owe that exploitation of *Drosophila melanogaster*, which is the basis of most modern developments. To him we owe the theory of the gene, which is fundamental, and the explanation of 'crossing-over', which forms the basis of the conception of the linear arrangement of the genes and the chromosomes. From these starting points all other work springs, and much of this work comes from Morgan himself, his associates and his students. Morgan has done more than any other man to establish genetics and thus to revolutionize our ideas in many different fields of work, in practical affairs as in pure theory.

ROYAL MEDALS

A ROYAL MEDAL has been awarded to Prof. PAUL ADRIEN MAURICE DIRAC.

Dirac's chief work has centred around the fundamental principles of modern theoretical physics. The new quantum mechanics was discovered by Heisenberg in 1925. Dirac at once realized the great importance of this discovery, started to work out its fuller implications and by a remarkable combination of originality, mathematical skill and uncanny instinct, rapidly established himself as a great leader in this field. His earliest efforts were directed towards tidying up the intermediate field between that of the new quantum mechanics and the Newtonian. An early and very important paper was on the fundamental equations of quantum mechanics. This was a generalization for which he introduced a new algebra, that of non-commutative numbers.

Probably Dirac's greatest achievement was that of ending the conflict between quantum mechanics and relativity mechanics by showing how to make the fundamental equations of quantum mechanics invariant under a Lorenz transformation, at any rate to a first approximation which has not yet been improved on. This led to a revision of the theory of the hydrogen atom which confirmed Sommerfeld's formula for the fine structures of spectrum lines and X-ray levels. This formula had been derived hitherto from a mixture of empirical results and theoretical guidance, but had not been deduced from general fundamental principles. The idea of a quantized electron spin also fitted naturally into the new theory. The harmonization of the quantum and relativity mechanics also required the introduction of the strange conception of negative energy states (holes) and this is generally regarded as a prediction of the existence of the positive electron (positron) since discovered by Anderson.

A ROYAL MEDAL has been awarded to Prof. DAVID KEILIN.

Prof. Keilin's contributions to entomology extend over nearly thirty years. In the main they concern the higher Diptera: with critical ability and a great capacity for detailed observation he has demonstrated the very close correlation that exists between larval structure and habits in these insects.

Prof. Keilin's main contributions to biochemistry have been his studies on the respiratory pigment, cytochrome, published in a series of papers from 1925 onwards. He has shown that cytochrome is composed of at least four components related to hæmatin. One of these is in all probability the enzyme previously known as indophenoloxidase. The catalytic activity of this enzyme depends entirely on co-operation with the other three components of cytochrome. The complete cytochrome system forms within the cell a highly active catalytic mechanism which by utilizing molecular oxygen can easily oxidize hydrogen atoms of certain substrate molecules which have been activated by dehydrogenase systems. This shows that the enzyme component of cytochrome may be identified with the previously undiscovered oxygen-transporting enzyme of Warburg and his co-workers.

Other work of Prof. Keilin in this field has included the characterization of certain oxidizing enzymes which make use of molecular oxygen, and the preparation in a pure condition of the polyphenol oxidase of mushrooms. The latter has been shown to be a copper protein compound. Recently he has

* From the remarks made by Sir William Bragg in presenting the medals for 1939.

also isolated in a pure state copper protein compounds from blood corpuscles and liver (hæmocuprein and hepatocuprein), which may be of biological importance though they are not apparently concerned in oxidase reactions. Keilin has thus provided us with an integrated picture of cellular respiration which is an enormous advance on the much less systematized knowledge that we had before his work was published.

DAVY MEDAL

The DAVY MEDAL has been awarded to Prof. JAMES WILLIAM MCBAIN.

McBain's claim to special recognition rests essentially on the circumstance that he created, and has led the development of, a new and important chapter of physical chemistry—the study of colloidal electrolytes. It was as the result of a long series of precision measurements on the electrical and thermodynamic properties of soap solutions that McBain originally defined this new class of materials, which combine in a special way the properties of colloids and electrolytes. The definition and constitutional theory proved to be the key to the orderly exploration, which thenceforth proceeded with continually growing impetus, of a large and fruitful field—incidentally one of considerable technical importance. The materials include soaps, nearly all modern synthetic detergents, a number of inorganic substances such as silicates and tellurates, as well as many dyes, proteins and bio-colloids.

In the continued investigation, in which numerous workers have contributed to the general development of the subject, McBain has been a leader, and his work has thrown much light not only on the special properties of the ionic micele, but also on the physical properties of colloidal particles as a whole. In the course of this work a great variety of experimental methods has been developed—chemical, electrical, optical and mechanical methods—which are novel in their application and are in some cases novel in themselves. Reference may be made to the quantitative study of 'solubilization' and the elaboration of the air-borne ultracentrifuge in illustration of McBain's versatility of technique.

In addition to the composition and organization of a colloidal particle, its interface with the continuum has a decisive influence on its properties, and this gives special importance to the section of McBain's work which deals with the structure, composition and depth of macroscopic interfaces, especially of the surfaces of colloidal electrolyte solutions. Here also he has devised many methods of study, one of the most striking being the 'microtome' method whereby the outermost layer of a solution can be peeled off with a rapidly moving knife blade so that the surface concentration of solute can be directly determined.

HUGHES MEDAL

The HUGHES MEDAL has been awarded to Prof. GEORGE PAGET THOMSON.

Thomson's researches have been spread over a wide range of experimental and theoretical physics. Most of his earlier experiments were connected in some way or another with positive rays, and in this field he obtained a number of valuable results. Probably the most important of these is his discovery that the small-angle scattering of protons in hydrogen could not be accounted for by treating the protons and electrons as point charges obeying the inverse square law of force.

The scope of his work in pure physics is indicated by the titles of three books he has written or, in one case, helped to write. These are: "The Atom", "Wave Mechanics of the Free Electron" and the third edition of "Conduction of Electricity through Gases". The last is a joint effort with his father, and is the most important work there is on the subject. Within this range his work is both experimental and theoretical, but the experimental part predominates both in quantity and in importance.

Thomson has also made notable contributions to aeronautics. They include research work for the fighting air services during the War of 1914–18, a book entitled "Applied Aeronautics" (1919), and various contributions to Government publications.

Thomson's most distinguished work is based on Davisson's discovery—finally established in 1927—that electrons were reflected by single crystals as if they were possessed of the characteristics of waves. By brilliant experiments and able reasonings thereon, Thomson has opened out a new field of research which has been singularly fruitful and is still full of promise. He has been able to prove by direct experiment the correctness of Louis de Broglie's ideas of wave mechanics, not merely qualitatively but also quantitatively.

THE GREAT RED SPOT ON JUPITER

THE presidential address of the British Astronomical Association was delivered on October 25 by Mr. B. M. Peek, who took for his subject the physical conditions of the planet Jupiter, and in particular the red spot. It is certain that Schwabe's drawings in 1831 showed this spot, and there is evidence that it was known from 1664, the date of Hooke's famous observation, until 1713, from which date a gap of more than a century exists in the records.

It is difficult to believe that a purely atmospheric phenomenon could have continued so long without showing signs of dissipation, but the anomalies of its motion in longitude militate against the view that it arises from a centre of activity more deeply rooted than the atmosphere. It rotates nearly in accordance with system ii, that is, the system which represents approximately the period of features commonly seen outside the equatorial zone, 9h. 55m. 40·632s. An attempt was made by Peek to determine what system of uniform rotation most nearly represents the rotation of the spot from 1891 until 1931, but it is admitted that a simple mathematical expression to represent the motion is difficult to find, and the investigator is obliged to ask the question whether, in spite of its long persistence, the red spot is not a purely atmospheric phenomenon. At this stage of

the inquiry it is necessary to define the term 'atmosphere'.

Both Wildt and Peek have shown that beyond a depth of 100 km. the atmosphere of Jupiter must be compressed to the density of the liquid or solid state of the substances composing it. It is possible to conceive of this atmosphere as composed of highly condensed permanent gases, and at greater depths these gases may be solidified. The temperature of the surface of such an atmosphere would probably be in the neighbourhood of 150° K. (− 123° C.), and from the dry adiabatic lapse-rate at the surface of Jupiter it is certain that the temperature must increase rapidly with the depth for the first few kilometres. When, however, the gas laws break down, it is probable that practically isothermal conditions prevail and the isotherm may be about 300° K. Jeffreys' investigations suggest that a thick layer composed of one of Bridgman's high-pressure modification of ice, probably ice vii, lies underneath, and Peek considers the case of an enormous berg, towering above the general level of the layer. Would the viscosity of the ice allow it to drift in longitude like the red spot?

Mr. Peek then develops a suggestion made by Wildt[1] that the spot may be a solid body floating in an 'ocean of permanent gases', and proposes the following tentative hypothesis: A solid body *A*, which is provisionally called ice, floats in a permanent gas *B*, provisionally called nitrogen. If the former is ice vii, it may be supposed that a small portion near the top would gradually change its phase from ice vii to ice vi, and, owing to the absorption of heat, the atmosphere above it would be cooled. The red spot is, it is thought, "a manifestation at the visible surface of the thermal effects accompanying the change of phase".

Assuming further that the level at which the ice floats is subject to small variations, the radius of gyration about the axis of the planet will vary, and a simple calculation shows that a total range of 10 km. would account for all the changes in velocity that the red spot has undergone during the period of investigation. While ice and nitrogen illustrate very readily the hypothesis, it is pointed out that the phase diagrams of other substances, such as hydrogen and helium, also suggest suitable conditions, and it is unnecessary to assume that ice and nitrogen are actually responsible for the phenomenon. It is hoped that the matter will be investigated more fully in the near future.

[1] *Proc. Amer. Phil. Soc.*, **81**, 2 (1939).

POSSIBILITIES OF ALTERNATING CURRENTS FOR LONG-DISTANCE TRANSMISSION

IN the *Electrical Review* of October 20, H. Rissik shows that some of our early notions about the transmission of electric power must be modified. In the past no difficulty was at first experienced in utilizing the line conductors to the full extent of their carrying capacity. Transmission distances were short and the power to be transmitted amounted to only a few thousand kilowatts. As time went on and transmission voltages and distances gradually increased, the view became common that any technical limitation to the amount of power that could be transmitted was to be looked for in the nature of the generating plant and transformers, rather than in those of the transmission line itself. It was seen that there was no longer a definite line voltage for a given power and distance giving the lowest transmission costs, which diminished as the voltage that could be used increased. Other characteristics of the electric plant had to be taken into account.

The special problems created by the linking up of immense power networks operating at 132 and 154 kv. and in many cases at 220 kv., involving power interchange over long distances, first became acute in the United States, and they have also arisen in France, Germany and the U.S.S.R. To the pioneer work of American engineers we are indebted for our present knowledge of the essential factors which contribute to system instability. They have also developed methods of improving the stable operation of power systems. It is very creditable that individual electricity undertakings, operating on a very large scale, should have deliberately subjected their power systems to major electrical disturbances in order to verify calculations based upon a new theory. This form of large-scale experimentation was on several occasions undertaken in the United States, notably in 1928 on the 220 kv. system of the Southern California Edison Co. and again in 1930 on the 132 kv. system of the West Penn Electric Co.

As a result of the experience accumulated during the last ten years, it has become possible to investigate technically methods whereby the stability of superpower trunk lines may be raised to levels where economics once more becomes the decisive factor. It has been for a long time common practice to employ a synchronous condenser at the load end of a transmission line in order to maintain the terminal voltage common at all loads. In 1921 Baum showed that this principle could be extended to a long line divided into several sections and having synchronous condenser stations located at the points of section. Taken as a whole this transmission line acquires the electrical characteristics of its individual sections. As the result of the reactive power compensation effected by the intermediate condenser stations, the voltage at each point of section is maintained constant and equal to the transmission pressure.

Another system is the self-tuned line. To every frequency of alternating current there corresponds a wave-length, such that their product equals the velocity of propagation of the train of electric waves, just as in radio, television and carrier communication. For overhead lines, the velocity of propagation is approximately equal to the velocity of light, that is, about 180,000 miles per second, so that the wave-length of a 50-cycle transmission line would be about 3,700 miles. Skilling showed in 1927 that if the transmission distance is just half the wave-length at the applied frequency, the line inductance and capacity cancel each other out and the line behaves

virtually as if it possessed resistance only. Such a line constitutes a tuned circuit which resonates at the frequency of the applied voltage. It would be difficult to realize this in practice as at the normal frequency of 50 the transmission distance would have to be 1,850 miles. This limitation of great length could be got over by the 'compensated line' system, where a series excitation scheme is artificially loaded with series capacitance. One successful application of this method was from a substation of the New York Power and Light Corporation at 33 kv. installed in 1928. The chief disadvantages of using large static condensers is their expense and their liability to damage by over-voltage.

Another possible method would be to load the line at intervals with shunt reactors, after the manner of the Pupin loading coils used in telephony, over underground cables. Such a dual compensated line would behave as if it possessed resistance only.

OPERATION AND DESIGN OF TROLLEYBUSES

A PAPER by G. F. Sinclair, of the London Passenger Transport Board, on the trolleybus system was published by the Institution of Electrical Engineers on November 9. The trolleybus has been adjudged by the Ministry of Transport an electric vehicle, and its construction and operation are governed by the Ministry's regulations. These allow the vehicles to be built one ton heavier than other forms of road passenger vehicle. They can be designed with large seating capacities with accommodation up to seventy passengers.

The cost of maintaining a 70-seater trolleybus is not greater than that of the much smaller unit, the Diesel bus. On a mileage basis the capital charges on the vehicles, taken over a period of twelve years, assuming similar seating capacities, show little difference when the two types are compared. The average energy consumption for trolleybuses operating on an intensive service is approximately 2·75 units per car mile, measured at the substation. The price of direct-current energy varies from 0·5*d*. to 0·8*d*. per unit. At the higher figure the cost per ton-mile is high compared with the Diesel bus, but at 0·5*d*. per unit the comparison is favourable to the trolleybus. For passenger services in densely populated areas, the vehicle with comparable costs, which can perform the cycle of starting and stopping to pick up and set down the greatest number of fare-paying passengers in the least time, will produce economies. The high acceleration of the trolleybus due to the overload capacity of its motor gives the facility for operating high schedule speeds. The ability to marshal vehicles in different areas is also a great convenience. In the everyday movement of the people on the road to and from their work, the use of non-stop vehicles plays little part. The travelling public have shown their appreciation of the comfort in travel, the fine riding qualities and quiet operation of these vehicles. The residential population and business people on the routes served by trolleybuses have greatly benefited from their smooth and quiet running.

Among the many points interesting to all electricians touched on by Mr. Sinclair is the production of electric charges on trolleybuses, and the methods of suppressing the interference with radio transmission signals, whether of sound or vision broadcasts. In service, the electric charges may be produced by the friction of the tyres on the road surface, by the rise of potential due to the inductive kick from the contactor coils, possibly by the mutual induction from the currents in the transmission mains, or lastly when a leakage occurs from the power circuits to the body of the car. It has to be remembered that it is only in very special circumstances that these conditions can arise. In any event they present little inconvenience to the travelling public. Consider a rubber-tyred vehicle with a metal or composite body; the generation of a charge depends largely on the road surface. With dry clean granite sets, voltages up to 900 can be measured by an electrostatic voltmeter immediately after the vehicle comes to rest. If the roads are asphalt or tar-macadam, only zero readings will be obtained. When the circuits of the electrical equipment are broken, the inductive charges may give voltages up to 300. Neither of these types of charges necessitates special precautions, as the frequency of loading or unloading passengers prevents high static charges from being built up. The use of 'low resistance' tyres, of about 2,000 ohms measured from the tread to the wheel rim, provides satisfactorily for earthing these charges.

It is the possibility of electrical leakage from the 600-volt circuits which has to be guarded against—the vehicle being in reality unearthed. The Ministry of Transport regulations require a daily test of the insulation of each trolleybus. The test is carried out after the vehicle has completed each day's service. Testing apparatus is located at the entrance of the depots. This enables the test to be carried out with the trolleybus in the condition in which it has been operating, an especially important point in wet or snowy weather, as the insulation resistance varies largely with the climatic conditions. For convenience in testing, the frames of the individual 600-volt units are connected by means of cables to a common testing receptacle, which is mounted at the back of the trolleybus underneath the platform. The nightly test is between the conductors and the body or chassis, the secondary insulation being short-circuited. Every fourteen days, each high-voltage circuit is tested individually, including all insulation whether primary or secondary. The insulation of the platform consists of a rubber mat secured to the floor boarding by an adhesive. The handrails have an insulated covering and are provided with secondary insulation, the combined arrangement giving insulation readings of 'infinity'.

The British Standards Institution has recently published a specification setting out the three methods used for reducing the electrical interference with radio broadcasting, etc., generated by the trolleybus equipment. The results of large-scale experiments carried out in London for preventing interference by trolleybuses are described.

On a fleet of more than 1,600 trolleybuses in London, the use of carbon 'shoes' to collect the current from the overhead wires is general. The success of the carbon collectors is due largely to the lubrication of the conductors.

SCIENCE NEWS A CENTURY AGO

Travels in Eastern Turkey

AT a meeting of the Geographical Society on December 9, 1839, a communication was read from Mr. John Brant, H.M. Consul at Erzurum, describing a tour of about 900 miles in the country lying to the south of Mount Ararat and the north of the River Tigris. Brant was accompanied by Dr. E. D. Dickson and A. G. Glascott, R.N., who had mapped the route followed and had also prepared a chart of a section of the high land of Armenia, between Trebizon on the Black Sea, and Mosul on the Tigris, a direct distance of 360 miles, showing the remarkable features of the elevated plateau, which for the greater part preserves a level of 6,000 ft. above the sea. Astronomical positions were determined of the principal places visited, resulting in the correction of many errors. Among the towns visited was that of Van on the east side of the lake of that name. The town had a population of about 35,000, half of whom were Armenians. The lake covers about 900 square miles and is 5,470 ft. above the level of the sea. By a special order of the Pasha, the party were able to visit the castle and caves and they also inspected the cuneiform inscriptions near Van, the Pasha expressing great anxiety to know if the party could translate them. An expedition was also made to the top of the mountain of Supan Tagla, 4,000 ft. above the lake and 9,500 ft. above sea-level, the theodolite being placed on the summit. From this spot could be seen to the north-east the beautiful peaks of the Great and Lesser Ararat, at a distance of 80 miles, rising into the regions of eternal snow.

Electro-deposition of Copper

"CONSIDERABLE interest has been excited in the scientific world," said the *Athenæum* of December 14, 1839, "by Mr. Spencer's new process of copying medals and other works of art, in copper, by the agency of voltaic electricity. It is with great pleasure we hear that this process is already beginning to be employed in certain of our manufactures, and that thus electricity will soon be numbered among the agents employed for practical and useful purposes. . . . In the manufacture of plated articles and ornaments it is often desirable to copy ornamental work, such as leaves, flowers and arabesque mouldings; this is both difficult and expensive, and from these causes often impossible. Mr. Spencer's invention, however, affords a cheap and easy method of performing what is required, and thus, ornaments on rich ancient plate are copied with the greatest perfection and ease, and without injury to the original. The great advantage consisting in the means of obtaining at very small expense, a facsimile in copper of the ornaments required to be copied, which may then be silvered or gilt. . . . The casts of medals, transmitted to us by Mr. Spencer, and also those made by Mr. E. Solly and Mr. J. Newman, and exhibited lately at the meeting of the Society of Arts, were very pure and compact copper, and the surface was as brilliant and perfect as could be desired. The process, indeed, is simple, and so far from its requiring, as is generally supposed, either expensive and complicated apparatus, or deep scientific knowledge, nothing can be more easy, as the observance of a few rules renders the success of the process quite certain, and, as regards the expense of the apparatus, the whole of it may be acquired for a few pence."

UNIVERSITY EVENTS

CAMBRIDGE.—During the vacancy in the professorship of chemistry, Dr. H. McCombie will be temporary director of the laboratory of general and organic chemistry—that is to say, all those parts of the chemical laboratory not at present assigned for the use of the professors of colloid science, theoretical chemistry, metallurgy, and physical chemistry.

In accordance with its usual practice, Trinity College, Cambridge, announces the offer of a research studentship open to graduates of other universities who propose to go to Cambridge in October next as candidates for the degree of Ph.D. The value of the studentship may be as much as £300 a year if the pecuniary circumstances of the successful candidate require so large a sum. Candidates must not have reached the age of twenty-six before May 1. In certain circumstances an election may be made to an additional studentship. The same College offers, as usual, Dominion and Colonial exhibitions to students of Dominion and Colonial universities who wish to go to Cambridge next October as candidates for the degree of B.A., M.Litt., M.Sc., or Ph.D. These exhibitions are of the titular value of £40, but their actual value is fixed by the College Council in accordance with the exhibitioner's financial circumstances. A candidate for a studentship or exhibition should apply through the principal authority of his university, and his application should reach the Senior Tutor of Trinity College (from whom further particulars may be obtained) by May 1, 1940.

OXFORD.—H. G. Champion, New College, has been appointed to the professorship of forestry, vacated by the death of Prof. R. S. Troup, as from Trinity Term, 1940.

Miss A. Pellew, St. Hugh's College, has been awarded the Edgell Sheppee Scholarship in engineering science.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

UNIVERSITY GRADUATES as Teachers of English for Colombia—British Council, 3 Hanover Street, W.1. (December 15, quoting 'Colombia').

SENIOR EXPERIMENTAL OFFICERS (Male), EXPERIMENTAL OFFICERS (Male), and EXPERIMENTAL ASSISTANTS (Male and Female) by the Ministry of Supply—The Ministry of Supply (S.E.3), The Adelphi, W.C.2 (December 20, quoting Appts.015/S.E.3).

WOMAN PROFESSOR IN CHEMISTRY at the Huguenot University College, Wellington, Cape—The Secretary, Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar Square, W.C.2 (December 31).

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Health. Memorandum on Influenza. Revised edition. Pp. 12. (London: H.M. Stationery Office.) 2d. net. [2111

Air Ministry: Meteorological Office, London. Southport Auxiliary Observatory (the Fernley Observatory of the Corporation of Southport). Annual Report, with Results of Meteorological Observations, for the Year 1938. By George A. Lidster. Pp. 32. (Southport: Fernley Observatory.) [2111

Other Countries

Smithsonian Institution: Bureau of American Ethnology. Bulletin 122: An Archæological Survey of Wheeler Basin on the Tennessee River in Northern Alabama. By William S. Webb. Pp. xv+214+122 plates. (Washington, D.C.: Government Printing Office.) 50 cents. [2211